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W. L. G. JOERG, 1885–1952*

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ON January 7, 1952, one of America's leading geographers, W[olfgang] L[ouis] G[ottfried] Joerg, Chief Archivist of the Cartographic Records Branch of the National Archives at Washington, D. C., died suddenly of cerebral hemorrhage at the age of sixty-six.[1]

* Mr. Joerg rarely used his first three names "Wolfgang Louis Gottfried," preferring the initials "W. L. G." This abbreviation stems, he once remarked, from the period of World War I.

[1] The following publications beautifully summarize or include portions of Mr. Joerg's life and his professional contributions and relate much of which accordingly there is only brief mention in this biography: "Resignation of Mr. W. L. G. Joerg from the Staff," *Geographical Review,* XXVII: 315–317; John K. Wright: "W. L. G. Joerg," *Geographical Review,* XLII: 482–488; John K. Wright, *Geography in the Making: The American Geographical Society, 1851–1951,* New York, 1952, 437 pp. Herman R. Friis, "The Polar Research and Publications of W. L. G. Joerg," to be published in *Journal of the Arctic Institute of North America.*

Additional sources of information, mainly in manuscript and typescript memoranda and letters, personal papers, maps, and notes, may be found in: 1) the archives of the American Geographical Society, New York City; 2) the permanent records of the Cartographic Records Branch (formerly the Division of Maps and Charts) in the National Archives, Washington, D. C.; 3) the permanent records of the Federal Board of Surveys and Maps in the National Archives, Washington, D. C.; 4) the permanent records of the Division of Geology and Geography in the National Research Council, Washington, D. C.; 5) the permanent records of the United States Board on Geographic Names (and its predecessor agencies) in the Division of Geography, Department of the Interior, Washington, D. C.; and 6) the personal papers and library left in the family. The writer has utilized the sources noted in 2) through 6) and correspondence he has had with Dr. John K. Wright, which reflect 1), as well as the three indispensable publications noted above in the preparation of this biographical sketch. Much of the information was acquired by the writer from conversations with Mr. Joerg over a period of fifteen years close professional and personal association (1937–1952).

The photograph of Mr. Joerg is from the official records in the Still Pictures Section, Audio-Visual Records Branch, the National Archives, Washington, D. C. This photograph was taken in the summer of 1950. Additional photographs of Mr. Joerg taken at various times since 1937 are on file in this Section and for the period prior to 1937 are on file in the archives of the American Geographical Society, New York City.

Published biographical information may be found in the following: 1) *American Men of Science,* Lancaster, Pa., 1949, p. 1264; 2) *Who's Who in America,* 1952–1953, Chicago, Ill.,

Until the day before his death he retained his customary mental and physical vigor and during the week was busily engaged in research and in making plans for summer field work in one of his favorite regions, the northeastern Appalachian Uplands. With characteristic thoroughness he was assemblying maps and notes on the region and planning the field work, which, in addition to being a study of the landscape, was to include a detailed survey of the sites of several eighteenth and nineteenth century German settlements from which, Mr. Joerg discovered, he derived certain ancestral origins. One of these, the Ole Bull Colony of the mid-nineteenth century, had so fascinated him that he was planning an intensive study of its historical geography and genealogy.

Mr. Joerg was born in Brooklyn, New York, on February 6, 1885, the only child of Dr. Oswald Joerg and Denise (Coulin) Joerg. His father, a German-born physician, and his mother, born in Geneva, Switzerland, early recognized the aptitude of their son, gave him every encouragement, and were largely responsible for his having a substantial cultural environment. He was a precocious child, giving much time to reading and at an early age acquired fluency in German and French, perhaps largely under the tutelage of an aunt whom he frequently referred to familiarly as "Tante." His wide reading and the tutelage of his aunt expanded his mental vistas far beyond those of the average youth. Early in life he found an absorbing interest in exploration and cartography. These interests remained with him throughout his life and doubtless sparked his competence in the field of geography. His interest in books and maps led him on many jaunts to museums and libraries, particularly the New York Public Library whose periodic exhibits of books, manuscripts, and maps quickened his historical sense. He once remarked that he was especially attracted to the cartographic exhibits, though he hastened to add that he was often distressed by the relatively few exhibits of modern American-made maps. He developed a sensitive library consciousness that became an inseparable part of his professional being and made of him one of geography's greatest sleuths, a master at finding that evasive last source. Rarely during his travels to new places or to familiar haunts did he fail to visit the local library to check its holdings and to search out those sources he could not find elsewhere.

After graduating from Brooklyn Polytechnic Preparatory School at fourteen, he searched in vain among American educational institutions for well-rounded courses in geography. This nearly total lack of an accredited curriculum in geography, Mr. Joerg later in life noted, was so different from the great strides that had been made in establishing geography as a major discipline in American universities during the past several decades. Inwardly he was mighty proud, for in this achievement he must have realized that he had played an important role. His

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1953, p. 1261; 3) *Directory of American Scholars* . . . Lancaster, Pa., 1942, p. 421; 4) John K. Wright and Elizabeth T. Platt: *Aids to Geographical Research* . . . , Research Series Number 22, American Geographical Society, New York, 1917.

Kenneth E. Bertrand, S. Whittemore Boggs, William Briesemeister, Meredith F. Burrill, Wilma B. Fairchild, Mrs. Sophia A. Saucerman, and John K. Wright kindly read the manuscript and offered helpful suggestions.

remarkable fluency in European languages and in the classics, as well as his early intellectual maturity, made possible his successful educational experiences in Germany at the Thomas Gymnasium and the University of Leipzig (1901–1904). Here his special aptitudes in geography and cartography were nurtured and, with the priceless associations he had with European, notably German, geographers, he became one of the richest sources of information about geography and its proponents possessed by any American geographer of the past fifty years. A year (1904–1905) was spent at Columbia University in New York City completing courses in engineering, surveying, and geography.

He returned to Germany in 1906 to complete nearly five years of undergraduate and graduate work at the University of Göttingen and part of a year at the University of Geneva (Switzerland). His selection of Göttingen, he once remarked, was arrived at after a careful appraisal of what the different universities at home and abroad had to offer in relation to what he was seeking in geography. His extensive reading of geographical literature convinced him that Hermann Wagner at Göttingen, editor of the *Geographisches Jahrbuch* and *Lehrbuch der Geographie*, was the geographer with a well-balanced scholarly approach. In 1911, shortly before Joerg began his duties with the American Geographical Society, he thus acknowledged a debt to Wagner in his letter to Cyrus C. Adams.

> To me it is particularly gratifying that at this period in my career the man to whom I owe the most for what I may do in the future is thus honored by this institution [Wagner was awarded the Cullum Geographical Medal] . . .[2]

During his stay in Europe he availed himself of every opportunity to travel into Austria, Switzerland, and France, and to take part in the *Wandervögel* bicycle tours that radiated out from Göttingen. Sometimes these jaunts were taken just for the sport of it, yet more often to Mr. Joerg they were cultural pursuits, for he made the most of his time visiting libraries, museums, and centers of music. In pursuing these tangents, as in his schooling, he was favored by having parents who supported and encouraged his interests. Yet, Mr. Joerg had a large measure of the Old World frugality that made it possible for him to stretch each allowance to the maximum. Then too, he said he traveled and lived third class whenever he could. Occasionally he earned extra money as a tutor and as a translator. Perhaps the highlight of his stay in Germany was the close association he developed with Professor Ludwig Mecking, a geographer for whom he had profound respect. Perhaps it was Mecking who inspired his interest in the geography and exploration of the polar regions. From Mecking he received valuable training in methodology, geographical research and presentation, and cartography. In the spring of 1909 Joerg accompanied Professor William Morris Davis' excursion for his students at the University of Berlin at which institution Davis was serving as an exchange professor. Davis was favorably impressed by Joerg's abilities.[3] This was the beginning of a close professional friendship.

His ancestral background, stemming from German and French origins, was so

[2] John K. Wright, "W. L. G. Joerg," *Geographical Review*, XLII: 482.

[3] *Ibid.*, p. 484.

greatly interwoven in his personality that he had the rare ability of comprehending and appreciating the subtle differences in meaning of the intellectual processes of the German and French minds. This was particularly valuable to him in his objective appraisal of the geographical work of each that he was called upon to apply in his studies and in his subsequent research and publications (especially his reviews).

Returning from nearly five profitable, happy years in Europe, fired with enthusiasm about the new science, geography, one of the great moments of his career unfolded; a call to the American Geographical Society in New York City in 1911, as an assistant to Cyrus C. Adams, editor of the *Bulletin.*[4] This close association with the American Geographical Society was to last for twenty-six years (through March 1937). His precise scholarship and editorial ability early were recognized and rewarded, first as Assistant Editor of the *Bulletin;* then as Associate Editor of *The Geographical Review,* 1916–1920; Editor of the Society's monographic publications, especially the *Research Series,* 1920–1926; and finally as Research Editor of the Society, 1926–1937.

One of Mr. Joerg's first duties as Assistant Editor was to shoulder the responsibility for preparing the "New Maps" section of each number of the *Bulletin.* During the first four months of his assistantship he developed a comprehensive descriptive pattern of listing the rapidly growing number of map entries which were first published by him in the October 1911 number of the *Bulletin.* This section grew to such proportions that the information was printed in fine type. The scholarly approach he took to the completion of each issue almost immediately placed him in the forefront as a cartobibliographer, a characteristic that found expression in the footnotes and bibliographies in all of his publications as well as editorial activities.

Shortly before Mr. Joerg joined the staff of the Society he completed several short articles for publication in the *Bulletin.* The substance of these articles, as many of those that were to follow, was based to a large extent on his experiences in Europe and his ceaseless vigilance in "being on the look" for significant news and scholarly articles appearing in European publications. One of these early contributions, his article on "Tectonic Lines of the Northern Part of the North American Cordillera," is the lead article in the 1911 third number of the *Bulletin.* This article, based on Edward Suess' monumnetal work *Das Antlitz der Erde,* Vienna and Leipzig, 1909, is an

> . . . attempt to present in outline the structural features of the northern part of the North American Cordillera, also based on Brooks' valuable geography of Alaska and on various reports of the geologic surveys of Alaska and of the United States.[5]

The map accompanying the article appears to be one of the few maps in the construction and drafting of which Mr. Joerg actually had an active hand, for he

[4] *Ibid.,* p. 151. Joerg probably was the first professionally trained geographer employed in the American Geographical Society and certainly the first possessing such a wealth of advanced academic training in the subject field.

[5] *Bibliography, I,* 1910, p. 161.

notes that "it . . . was compiled and drawn by W. Joerg, 1910." This article demonstrates Mr. Joerg's particular skill in synthesizing and describing broad general regions, a quality he expressed so often in his writings. He frequently remarked that a geographer's principal objective should be "to master his subject and conduct his research so well that when he came to describe a region or a realm he could paint his own picture with broad well-coordinated strokes." He felt that to become involved in a multitude of small areas was to defeat the primary *raison d'être* of geography.

Mr. Joerg's mastery of German and French and his continuous reading of the geographical literature in these languages made it possible for him to prepare numerous reviews and summaries of the contents of articles, thus making available to his American colleagues much valuable information. Among his first contributions are his reviews of Ernst Prils' *Vergleichende Untersuchungen über Flussdichte* (Hamburg, 1910) and *Geography in Germany.* "Mr. Joerg's fluency in French and German, and his tact and scholarship, were invaluable assets and won him the esteem of his fellow travelers . . ." on the great "Transcontinental Excursion" of 1912.[6] Joerg was assistant to Professor William Morris Davis, director of the excursion, and was responsible for assembling a select library of maps, books, and articles that was to accompany this first sponsored transcontinental geographical excursion, many members of which were prominent European geographers.[7] The principal product of this excursion was the *Memorial Volume,* the first book published by the American Geographical Society. Significantly, Mr. Joerg was editor and was responsible for seeing it through to publication in 1915. The excellence of this publication established his prestige in the field and was partly responsible for the amicable relations between American and European geographers that grew out of the excursion.[8]

Mr. Joerg's intense interest in cartography, especially the map as a graphic medium of presentation, found expression in several of his first publications, notably "On the Proper Map for Determining the Location of Earthquakes," presented as a paper at the first annual meeting of the Association of American Geographers in 1911. This article, an outgrowth of one of his research papers given in a seminar under Professor Mecking, includes a map prepared by Joerg. He observes that

> The problem of determining the seats of earthquakes by means of seismograms then allows of various solutions. Aside from the 'laboratory' methods of using of wire system of coordinates fitted to a globe, three graphical solutions [the Mercator, Postel, and the stereographic projections] have been discussed.[9]

During this early period of his professional life Mr. Joerg contributed a number of definitive studies of the techniques and status of mapping, especially in the

[6] John K. Wright, *Geography in the Making . . .*, p. 163.

[7] Albert Perry Brigham, "History of the Excursion," in *Memorial Volume of the Transcontinental Excursion . . .*, p. 11.

[8] John K. Wright, *op. cit.,* p. 166.

[9] *Bibliography, I,* 1912, p. 54.

United States. He was laudatory in his remarks about the initial production of the first sheet of the International Map of the World covering a portion of the United States, but his keen disappointment over the failure of the hoped-for progress and completion of the project remained with him to the closing days of his life. So well known had his abilities in the field of cartography become that in 1914 he was named editor of the section on cartography in the *American Year Book . . .*, a position he held through 1940. Perhaps his first publication on the Arctic was his "brief statement as to the origin and scope of the Map of the Arctic Regions . . ." which appeared in volume forty-five of the *Bulletin* (1913), he being responsible for the "final revision (as assistant editor) exclusive of soundings."[10]

Mr. Joerg's masterful review of Alfred Hettner's "Geographische Anschauung" is an example of his ability to translate a complex philosophic study and to expand that translation to include a full share of his own philosophy on the subject of geographical visualization.

> We thus see that the most important function of geographical teaching is to convey a vivid image of the countries and regions of the world. If it fails to do so it is not worthy of the name. The change from word geography to map geography, the substitution of a thorough comprehension of the geographical ground plan for a knowledge of geographical names only represented a great step in advance. But the ground plan alone is only the outer form, the shell, as it were, which is devoid of importance and educational value unless it is supplemented by the power to visualize the regions and countries of the world . . .[11]

Mr. Joerg was one of the first American geographers to appraise and espouse the regional concept in geography. In this field he became a perfectionist, not so much in the actual description of a particular region as in developing a philosophy. His paper "The Subdivision of North America into Natural Regions; A Preliminary Inquiry," presented at the third annual meeting of the Association of American Geographers (1913), set the stage for the many similar studies that have been completed by others since that date. Significant among his remarks in this paper is the statement that

> With the recognition of regional geography as the ultimate goal and highest expression of geographical research which has come with the modern development of our new science, there has been a marked increase in the attention devoted to the subject and to its methods. One of the most important questions of method is that which refers to the unit of investigations. Economy of presentation and sound geographical reasoning both demand that such units be as homogeneous as possible.[12]

A natural outgrowth of Mr. Joerg's regional concept philosophy was his penetrating study of "The Geographic Center: Its Definition and Determination," prepared for presentation in 1915. This paper was to include a

> . . . general discussion of the problem of the 'center of gravity' in its applicability to geographical phenomena. After a consideration of the three types into which these phenomena have been divided (1. punctual: e.g. cities, 2. linear: e.g. railroads and other transportation systems,

[10] *Bibliography, I,* 1913, p. 610.
[11] *Bibliography, I,* 1913, p. 923.
[12] *Bibliography, I,* 1914, p. 55.

and 3. areal: e.g. continents, countries, etc.) and the methods of determining their centers, the third type was examined in greater detail. Such topics as centers of areas . . . , the poles of the land and water hemispheres, centers of population and median points (Census Bureau) were discussed, as well as the nucleii of phenomena represented by 'isarithmals' such as contours and isobaths, isobars, isobyetals, lines of equal density of population, etc. This paper concluded with an estimate of the extent to which geographical centers may be used to express succinctly certain geographical relations.[13]

One of the highlights of Mr. Joerg's early editorial days developed out of his factual reporting of "Col. [Theodore] Roosevelt's Exploration of a Tributary of the Madeira." Colonel Roosevelt called on Joerg to express his pleasure at the "objective reporting of what had been explored as contrasted to the sensationalism of certain newspapers."[14] Mr. Joerg's interest and competence in toponymy appears to have been well developed by this date, as he often made much of the generics and mode of use of place names.

Shortly before World War I Mr. Joerg initiated work on a project at the American Geographical Society which was to lead to the compilation of a "geographic map of New York City," but which had to be dropped because of the war.[15]

In 1917 a reorganization of the American Geographical Society under the new Director, Dr. Isaiah Bowman, placed Mr. Joerg in the very responsible post of Editor of the newly conceived *Geographical Review,* a post he carried almost single-handed through the War years to 1920. Mr. Joerg's professional background and his unusual grasp of the antecedents of World War I placed him in a most favored position as editor, especially since the trend of interest was strongly in favor of political geography.[16] His activities were not limited to that of Editor of the *Review* for he was responsible during the War for

assistance in the preliminary work at the American Geographical Society of the American Commission to Negotiate Peace, known as the 'Inquiry' through the editing of articles and maps dealing with the geographical problems of the War for the Geographical Review; preparation of a series of pamphlets dealing with ethnographic and other types to accompany a series of base maps prepared for the 'Inquiry'; preparation for the Committee on Public Information of the official map of the new boundaries of Germany released to the press by that organization on May 7, 1919, with the signing of the peace treaty draft.[17]

Two of his articles in the *Review* of this period stand out for their timeliness. The first, "European War Maps," was of widespread interest because he indicated the two classes of maps, detailed topographic maps and general maps that were readily available for use in a study of the military campaigns, and followed this general discussion with a "list arranged according to battle fronts, a brief characterization [of which] is added in brackets after the title of each map." His second article, "The New Boundaries of Germany According to the Peace Treaty," describes the

[13] *Bibliography, I,* 1915, pp. 127–128.
[14] Verbal statement by W. L. G. Joerg to H. R. Friis in 1950.
[15] John K. Wright: *Geography in the Making . . . ,* p. 180.
[16] *Ibid.*, p. 254.
[17] *Bibliography, I,* 1919, p. 61.

cartographic changes in the boundary and includes a descriptive statement, with relevant basic sources, about the changes in boundaries of the other European countries.

His article in the *Journal of Geography* in 1918 describes the "new look" of the American Geographical Society. In 1920 he was appointed Editor of the new *Research Series,* a post he was to hold during the remaining seventeen years of his stay with the Society.[18] This launched him on the most productive period of his life and the one for which he was especially well fitted.

It is of interest to note that during Mr. Joerg's twenty-seven years with the American Geographical Society his office was immediately adjacent to the Map Room, an especially significant association during the period of his being Research Editor, because he was almost slavishly dependent upon maps in his every research need. Mr. Joerg exerted profound and sustained influence on the quality and scope of geographical research, the products of which finally emerged as some of the finest examples of the best in geographical publications, namely the *Research Series,* numbers 1 through 17, and eight *Special Publications* which were edited by him during his seventeen years as editor. An examination of the publications in these two series listed as Parts II and III of the Selected Bibliography will reveal the wide variety of subjects and the excellence of scholarship for which he was responsible.

Though his own professional interests and accomplishments were almost entirely in the field of geography, his position as Research Editor insured that he would maintain a continuous and lively curiosity in intellectual accomplishments in a wide variety of disciplines. This curiosity was further stimulated by his remarkable proficiency in foreign languages which opened up to him the products of scholarship in other lands, a proficiency surprisingly few American scholars have attained. Indeed, an examination of the "standard or personal copy" of his publications and especially the *Research Series* reveals innumerable marginal notes, footnotes, and bibliographical entries in ink and pencil, annotations of information and changes in the text made years after the date of publication. He was bringing his publications "up to date."

One of the byproducts of his first publication as Research Editor (Numbers 1 and 2 Frank A. Golder's *Bering's Voyages: . . .*) was "Bering's Two Expeditions to Determine the Relation of Asia to America," a paper read at the tenth annual meeting of the Association of American Geographers in Chicago in 1920. This paper dealt with the expeditions of 1725–1730 and 1733–1741. It was illustrated by two wall maps, one a reconstruction by Bertholf of the tracks of the St. Peter and the St. Paul and the other being a present-day interpretation of the land and sea route of Bering's first expedition. It is important to note that in accomplishing these tasks Mr. Joerg studied Russian in order to "get at the original sources" that Professor Golder had reproduced from the Archives in St. Petersburg.

On May 21, 1921, Mr. Joerg, mainly subsidized from funds in the Society,

[18] John K. Wright, *Geography in the Making . . .*, p. 211.

sailed from New York for a six months tour of good will and investigation of the "status and tendencies of geographical work of learned societies and in universities and colleges in Europe."[19] During this time he attended the meetings of the geographical section of the British Association for the Advancement of Science at Edinburgh (September 7 to 14) and, as official representative of the American Geographical Society, attended the centennial celebration of the Geographical Society of Paris, July 4 to 7. His paper "Some Observations on the Present Status of Geography in Western and Central Europe," read at the annual meeting of the Association of American Geographers in Washington in December 1921, and the article of the same title in the *Geographical Review,* later reprinted as a publication of the National Research Council, is probably the most comprehensive "on the spot" research publication of its kind published to this date.

In 1922 Joerg was elected a Councillor of the Association of American Geographers for a term of two years. His interest in "the use of airplane photography in city geography" was expressed in a paper he read before the annual meeting of the Association in Ann Arbor, Michigan, in December. This paper

> Dealt with that fundamental element in the study of geography, city maps on an adequate scale, say 1:15,000, which show the built-up areas, and the means now afforded by airplane photography to supply the element easily. This new means is especially valuable in the study of American cities. . . .[20]

An article on "Port-War Atlases: A Review" in the *Geographical Review* of 1923, was a product of Mr. Joerg's reflection on the inadequacies in most of the atlases published during the War and of the atlases of the post-war era which he maintained "reflect the broader understanding" of geography. His review of some dozen atlases is an example of an impartial critical appraisal of their merits and deficiencies, the Times Atlas being considered the best general atlas. This article was followed in 1924 by a publication on "Recent American Wall Maps: A Review" in which he discusses the evolution of American-made educational wall maps, which, especially since the war, "represents the first full tide of the modern period." He observes that these show that "we have definitely entered the path of emancipation from the slavish copying of European models . . ."[21]

Mr. Joerg's special interest in and frequent references to the need of an objective approach to the concept of a geographic region was largely responsible for his being made Chairman of the Committee on the Geographic Provinces of North America in the Association of American Geographers. In August 1924 he read a paper on "Human Use Versus Natural Regions: A Preliminary Report of the Committee on the Geographic Provinces of North America," at the meeting of the British Association for the Advancement of Science in Toronto. The following December, a similar paper was read at the annual meetings of the Association of American Geographers. In this paper he received the evolution of the regional method with

[19] *Geographical Review,* XII: 437.
[20] *Bibliography, I,* 1923, p. 211.
[21] *Bibliography, I,* 1924, p. 464.

special reference to North America and brought up the question of including human factors in the delimiting criteria. This committee included C. O. Sauer, O. E. Baker, C. R. Dryer, R. DeC. Ward, and Joerg. Joerg noted that the

> motive that led to the creation of the committee was stated to be the desire for the establishment of regions that are related to man's activities in contradistinction to regions that are purely physical.[22]

In the following year the Council of the Association of American Geographers named Joerg Chairman of the Committee on the Delimitation of Geographic Regions. In 1925 he was appointed a contributary editor of *Bibliographie Géographique Internationale,* Paris, France, which association was to last through 1937.

In 1926 Joerg was appointed the representative of the American Geographical Society in the Division of Geology and Geography of the National Research Council. This association lasted almost continuously to the time of his death.[23] At the annual meetings of the Association of American Geographers in 1926, a conference meeting considered the subject of methods of fieldwork in the study of small areas. Mr. Joerg's comments though mild, nevertheless, reflect his great concern that not enough geographers would learn to generalize. They are worth recording.

> The work represented by these papers is among the most distinctly geographic being done by members of the Association. It has been begun, it seems, partly because of the conviction of those carrying it out that geography has suffered from too much superficial generalization and that this generalization is in part connected with the attempt to treat large areas for which detailed intensive studies are still lacking. The point of view is already bearing its fruitful results, but it is to be hoped that it will be realized that there is room and justification for both methods in georapghy—the intensive detailed study of a small area and the broader synthetic discussion of a large area, each demanding its own technique.[24]

In 1928 Mr. Joerg, in recognition of his contributions to geography, was elected Vice-President of the Association of American Geographers, and was appointed Secretary of the American Section of the International Geographical Union, a post he held through 1937.

The geography and exploration of the polar regions had fascinated him, Mr. Joerg once mentioned, at a very early age, for as he said, "it was a sign of the times." His youthful curiosity and excited interest in the Arctic and Antarctic, made the more dramatic by the expeditions of Peary and others, were matured and sharpened during his studies under Professor Ludwig Mecking in the University of Göttingen in 1906–1911, for Mecking was one of the leading authorities on the geography of the polar regions. It is interesting to note that though Mr. Joerg never had seen the Arctic or the Antarctic, he nevertheless became so proficient in the literature and in the knowledge of their geographic landscape that legion are those whose explorations and work in these regions brought them to Mr. Joerg for

[22] *Bibliography, I,* 1925, p. 39.

[23] See *Annual Reports of the Division of Geology and Geography, The National Research Council, 1926–1952.*

[24] John K. Wright, *Geography in the Making . . . ,* p. 277.

assistance and advice. As fruitfully as he gave so fruitfully did he receive and accordingly build up a considerable reservoir of knowledge, much of which was expressed in published form, but, because of his sensitive modesty, often without his signature.

His editorial work on the two volumes of Professor Frank Golder's *Bering's Voyages* . . . (1922 and 1925) gave him an excellent opportunity to prove his abiltiy in successfully mastering a large volume of complex sources. In his letter to Dr. John K. Wright of the American Geographical Society early in 1951, Mr. Joerg notes that he had

> . . . absorbed Mecking's knowledge and experience, as later embodied in the Polarländer. . . . *Ergo*, when the situation was ripe I was prepared and ready to supervise a polar program when Dr. Bowman thought the time had come. This he sized up to be the period, my memory is, when newspaper publicity was running rampant and the sensational elements were predominantly over the scientific, . . . and wise man that he was, wanted to turn these media into channels benefiting science. . . .[25]

Accordingly there was launched in the Society a program of polar research with Mr. Joerg as Research Editor in charge of most of the research and publication. Perhaps the outstanding products of the program were *Problems of Polar Research* . . ., 1928, and the companion volume, *The Geography of the Polar Regions* . . ., 1928. The former includes scientific contributions by thirty-one leading polar specialists, the latter, edited by Mr. Joerg, consisted of Otto Nordenkjöld's "Polar Nature: A General Characterization" and Joerg's translation and editing (with the assistance of Miss Marion Hale) of Ludwig Mecking's "The Polar Regions: A Regional Geography." The large amount of research, editing, map compilation, and administrative planning that went into these volumes and the editorial perfection which Mr. Joerg achieved in readying his and other contributions by polar experts for publication in *The Geographical Review* went far toward establishing his reputation in the subject field.

His experience and large fund of information found expression in 1930 in a popular, well documented publication . . . *Brief History of Polar Exploration Since the Introduction of Flying*. . . . This concise survey of Arctic and Antarctic expeditions since the introduction of the use of the airplane and the airship as well as related scientific information, was so well received that in the same year an expanded revised edition was issued. In the same year he assembled and edited *The Work of the Byrd Antartcic Expedition, 1928–1930,* a "narrative unique among scientific documents in that it is derived from the radio dispatches received day by day . . . from the expedition's station 11,000 miles away. . . ."[26] This booklet of seventy-one pages was distributed by the Society to some 20,000 public schools and libraries in the United States. He was responsible for the preparation of a four-sheet map of the Antarctic (scale 1:4,000,000) to assist the first Byrd expedition (1928–1930). His interest in the mapping of the polar regions found expression

[25] John K. Wright, "W. L. G. Joerg," *Geographical Review,* XLII: 486.
[26] *Bibliography, I,* 1930, see introduction.

in the translation, revision, and publication of the *Andree Handatlas* (1924) "Physical Map of the Arctic . . . 1 : 20,000,000" by the American Geographical Society, 1929, and in the compilation of a "Bathymetric Map of the Antarctic . . . 1 : 20,000,000" published by the Society in 1929 with an explanatory booklet.

Most of Mr. Joerg's interest in the polar regions was concentrated on the Antarctic. In 1929 he presented a paper on "The Significance of Bellinghausen's Antarctic Voyage of 1819–1821," at the annual meeting of the Association of American Geographers in Cambridge, Massachusetts. This was followed in 1931 by a paper "The New Era of Antarctic Exploration, 1928–1931: A Summary of Results," given before the Association of American Geographers in Ypsilanti, Michigan; and in 1936 by a paper "The Geography of the Antarctica: The Advance of a Decade (1926–1936)" before the Association of American Geographers in Syracuse, New York. In 1937 he summarized the "Present Status and Knowledge of the Antarctic" in a paper read at the annual meeting of the American Society of Photogrammetry in Washington, D. C. and in 1940 at the meeting of the American Philosophical Society he read a paper (later published) demonstrating the "Peninsularity of Palmer Land, Antarctic, through Ellsworth's Flight of 1935." His collaboration with Dr. Kenneth E. Bertrand and Captain Harold E. Saunders in the article "The True Location of Stefansson Strait and Hearst Land, Antarctica," 1948, is an excellent example of teamwork in scholarship.

Mr. Joerg's publications on the polar regions are included in the bibliography at the end of this paper. An examination of each of them reveals the painstakingly careful scholarship with which he completed each segment of presentation and the meticulous search he conducted for all pertinent information. Some of his most significant contributions came as a result of his service as chairman of the "Special Committee on Antarctic Names," on the United States Board on Geographical Names, Washington, D. C., 1944–1947, and as a member of the "Advisory Committee on Antarctic Names" to the United States Board on Geographical Names, Washington, D. C., 1947–1952. One of the products of these activities was Mr. Joerg's collaboration in the publication of *The Geographical Names of Antarctica*. His wide range of information and intimate knowledge of the objectives and results of the many expeditions into the Antarctic qualified him as an objective "expert" and a just arbiter in the final selection and decisions of the official geographical names of that region.

In May 1944 Mr. Joerg was invited to meet in New York City with a number of eminent polar explorers and specialists, the purpose of the meeting being to lay plans for the creation of an association of polar specialists. The Arctic Institute of North America, of which Mr. Joerg was a Charter Member, founded in 1946, was an outgrowth of this and subsequent meetings.

Mr. Joerg's editorial work and intellectual curiosity led him into many different channels of information, one of which was the use of maps in air navigation. At a Conference on Air Navigation Maps held in the American Geographical Society on October 29, 1929, it was resolved that 1) the group should be formed into a per-

manent committee and 2) that Mr. Joerg should be made chairman of this committee and "be empowered to appoint an executive committee . . . "[27] Experimental work was to be initiated as soon as possible on air navigation maps of the United States and of South America. This special use of maps continued to excite Joerg's interest to the closing days of his life and was a subject about which he was frequently consulted, especially during World War II.

His intimate knowledge and objective appraisal of the professional and scientific contributions of his colleagues, as well as early geographers and lithographers, led to his being asked to prepare definitive biographical sketches of several of them, notably Julius Bien (1929), Cyrus C. Adams (1931), August Hoen (1932), Henry S. Tanner (1935), Leon Dominion (1936), and Erich von Drygalski (1950).[28]

In a paper on "The Numerical Distribution of Population of the World According to Climate," read at the 1930 meeting of the Association of American Geographers in Worcester, Massachusetts, Mr. Joerg observed that

> The fundamental importance of climate among the elements constituting man's physical environment makes it desirable to know how the population of the world is distributed among the different types of climate. Possibly the most feasible way to determine this is to calculate the number of inhabitants living within the areas indicated on a world map of climatic provinces. . . .[29]

For the purpose of illustration he selected Griffith Taylor's major economic regions as the simplest base for an experimental calculation and then gave the 1930 (?) population figures for each of the seventy-five regions, noting that these regions corresponded closely to climatic provinces.

During the early 1930's the staff of the American Geographical Society, under the leadership of Dr. Isaiah Bowman, gave considerable thought to and undertook much planning for several atlas projects, especially one on *International Relations* and another on the *Economic and Social Geography of the United States*.[30] Joerg devoted much time and thought to the preparation of a prospectus for each, but, lamented Mr. Joerg, "the 'Depression of the Thirties' precluded the fruition of these projects."

The decade of the 1930's was one of recognition by his colleagues of his scholarship and major contributions to geography. It was perhaps the busiest ten years of his life for in addition to his continuous research and publications, he served on many committees and held significant offices in geographical organizations. Significant among these are his appointment to committees in the Division of Geology and Geography of the National Research Council; election as President of the Association of American Geographers (1937); appointment as Secretary of the National Committee of the United States in the International Geographical Union; appoint-

[27] *Geographical Review*, XX: 148–149.

[28] In addition to the preparation of these and other biographies Joerg, because of his wide association with geographers in the United States and in Europe, was often consulted for biographical sketches of other geographers.

[29] *Bibliography, I*, 1931, p. 128.

[30] John K. Wright, *Geography in the Making* . . . , p. 229.

ment as a member of the Science Advisory Board, the Federal Board of Surveys and Maps, and the United States Board on Geographical Names; and appointment as representative of the Archivist of the United States in a consultative capacity with the United States Antarctic Service, 1938–1942. In these activities Mr. Joerg demonstrated his abilities as a moderator as well as a professional geographer.

During the summer of 1931, in company with Dr. Bowman, he attended the Thirteenth International Geographical Congress in Paris as official representative of the American Geographical Society and the Government of the United States.[31] Mr. Joerg served as chairman of the Section on Geography, Education and Bibliography.

Dr. Bowman's interest in and awareness of the significance of a study of frontier areas and pioneer settlement prompted him to select Joerg as editor of an American Geographical Society research project in and publication on ". . . Pioneer Settlement: . . ." (1932). Joerg was largely responsible for directing and editing this major contribution, a result of the cooperative efforts of twenty-six authors, and for a vast amount of painstaking bibliographical research. This publication, as one favorably impressed reviewer stated, "is a credit to the great society that sponsored it."[32] Recognition of his major contributions in this field came to Joerg when late in 1933 he was appointed to serve as a member of the Science Advisory Board for two years.[33] One of his principal responsibilities was to work with Professor Carl O. Sauer in the preparation of a comprehensive report for the Board on the subject "Land Resources and Land Use in Relation to Public Policy." Joerg "edited and annotated the report, conducted conversations with government officials, and assisted in the work of certain government groups in the study of problems of land use." While on the Board he served as a member of Professor Douglas Johnson's committee on the "Surveying and Mapping Services of the Federal Government."[34] As a contribution to the resulting publication by the committee and because he acquired an extensive knowledge of the mapping activities of the Government he became well-qualified for his later appointment as Chief of the Division of Maps and Charts in the National Archives. Mr. Joerg's intimate knowledge of land use policies and pioneer settlement were largely responsible for his serving as editor, jointly with Dr. W. A. Mackintosh, in the publication of the nine-volume series on "Canadian Frontiers of Settlement" (1934–1936).

Joerg's study of "Research Problems in National Science Bearing on National Land Planning," published in the Second Report of the Science Advisory Board in 1935, is based in the main on Sauer's report of the year before.[35] Joerg develops particulary the importance of having adequate large-scale topographic maps of the

[31] John K. Wright, *Geography in the Making . . .*, p. 230.
[32] Review by R. O. B. in *The Geographical Journal*, LXXXII (1933): 169–170.
[33] *Geographical Review*, XXV: 330 and XLII: 487.
[34] *Ibid.*
[35] *Bibliography, I*, 1934.

United States and emphasizes that they are "basic to all planning and an ordered national life."

At the 1934 meeting of the Association of American Geographers at Evanston, Illinois, Joerg, in response to Professor Preston E. James' paper on "The Terminology of Regional Description," remarked that

I should not like this discussion to go long without emphasizing the fact that the speaker has made a major contribution on the subject of 'detailed' versus 'generalized' study. . . . Neither is wrong in method; each has its justification. It is a question of scale or order of magnitude.[36]

This conference on regions was considered to have been so successful that a similar conference was held at the annual meeting in December 1934. At this meeting Mr. Joerg, in his prepared response to Professor Robert B. Hall's paper, observed that

. . . the early proponents of natural regions had in mind as one of their goals, the organization of geographical material. Geography was developing away from the rather barren discussion of political units in the old-fashioned statistical manner and the new idea was to break away from that and to recognize that by trying to establish areas that have fairly homogeneous conditions. . . .

. . . I think some of us at times have concentrated a bit too much on the boundaries and not enough on the regions and especially their cores;[37]

Mr. Joerg was quick to champion serious studies in regions of the hydrosphere as well as the lithosphere, as may seem from a paper on "The National Regions of the World Oceans According to Schott," which he read at the Sixteenth Annual Meeting of the American Geophysical Union at Washington in 1935. This paper was based on an advance proof of Gerhard Schott's map which shows the oceanographical regions of the world.

Professor Henri Baulig's *Amérique Septentrionale* Paris, 1935–1936, served as the springboard for one of Mr. Joerg's most valuable contributions, "The Geography of North America: A History of its Regional Exposition," which appeared in the December 1936 number of the *Geographical Review*.[38] Joerg is at his best in this article for, with his aptitude in French, he was sensitive to Baulig's beautiful construction and presentation and he waxed warm in praise when he wrote

. . . there is a conciseness and informed restraint that convey a sense of power—the power that comes from consummate mastery of the material. For such it is. Every subject that has a bearing on geography, from geology and physiography to economics and the social sciences, has been drawn on where needed and with complete sureness of touch woven into a composite picture of the region under consideration. This, indeed, is the reconstruction of truth—real geographical synthesis. . . .[39]

[36] "Conventionalizing Geographic Investigation and Presentation," *Annals of the Association of American Geographers*, XXIV: 77–122. For Mr. Joerg's response to Preston E. James' paper "The Terminology of Regional Description" (pp. 78–92), see p. 90.

[37] "A Conference on Regions," *Annals of the Association of American Geographers*, XXV: 121–174. For Mr. Joerg's response to Robert B. Hall's paper "The Geographic Region: A Resumé" (pp. 122–130), see p. 131.

[38] John K. Wright, *Geography in the Making* . . . , pp. 276–277.

[39] *Bibliography, I*, 1936, p. 653.

Joerg's article is the more valuable because with characteristic thoroughness he precedes his discussion of Baulig's work with a historical resumé of the regional geographies of North America that had been published prior to Baulig's work.

At the joint meeting of the American Geographical Society and the Population Association of America at Princeton University in October 1936, Joerg, using an exhibit of selected examples of population maps of different types, illustrated certain problems that Dr. John K. Wright had raised in a paper preceding his.[40]

March 31, 1937, was an auspicious date to Mr. Joerg for it marked not alone the only change in jobs that he made during his life, but it gave him a golden opportunity to realize fully a life-long ambition—specialization in the historical geography and cartography of North America. On this date Joerg was appointed Chief of the Division of Maps and Charts in the newly organized National Archives in Washington, D. C.[41] Mr. Joerg's competence in geography, his wide knowledge of the history of mapping of the United States, and frequent professional associations with most of the mapping agencies of the Federal Government, gave him unique qualifications for this post. During the fifteen years he held this position he was largely responsible for creating the nucleus of one of the most significant research centers in the historical geography and cartography of North America and for pioneering in a profession then unique and now recognized as of fundamental importance to geographical research.

In addition to the prestige and continuous associations with a professional staff in the National Archives, this new position gave Mr. Joerg opportunities for expanding his already significant contacts with other scientists and outstanding personalities in the Washington area, associations which were close to his heart and so much a part of his active life. Aware of the obligations of his new and varied adminstrative duties, he, nevertheless, found it possible to combine these with a surprisingly large amount of research, most of which was in the fields of historical geography and cartography and the geography of the polar regions.

One of Joerg's first duties as Chief was to assist the several groups of archivists in the National Archives in a survey of the records of the Federal Government and in establishing the fundamental policies of the Federal Government with respect to the appraisal, disposal, and permanent preservation of the official cartographic and geographic records. A lasting tribute to the genius with which he accomplished these obligations has been achieved, in part at least, in the nearly one million individual maps and related records which, over the last fifteen years of his life, were appraised and accessioned by the National Archives for retention as permanent

[40] John K. Wright, "Notes on Statistical Mapping, with Special Reference to the Mapping of Population Phenomenon," *Mimeographed Publications No. 1*, American Geographical Society of New York, 1938.

[41] See *Quarterly Reports of the Division of Maps and Charts*, the National Archives, June 1938, by Mr. Joerg. For an excellent historical sketch of the Division of which he was Chief (1938–1952) and of his professional and administrative activities see these and his annual reports on file in the National Archives, Washington, D. C.

records in the Cartographic Records Branch (formerly the Division of Maps and Charts).[42]

Perhaps Joerg's first public expression of the function and future of the Division was included in his "Remarks on the Work of the Division of Maps and Charts" made before the American Society of Photogrammetry in Washington, D. C., on July 23, 1937. This was followed by the preparation of a statement about the activities, for inclusion in the *Handbook on the Map Collections in the District of Columbia* in 1937.

In recognition of his scholarship and numerous contributions in the field of geography Mr. Joerg was elected President of the Association of American Geographers for 1937. It appears from a manuscript extant in the National Archives that Mr. Joerg had intended to develop his presidential address of December 1937 around a theme of historical geography for among his official papers is a hithero unpublished manuscript "The Internal Improvement Maps (1825–1835) in the National Archives" and some two dozen lantern slides of illustrative materials, a footnote indicating that they were prepared for reading at the December 1937 annual meeting.[43] Unfortunately, Mr. Joerg was unable, because of illness, to attend this meeting, nor has a presidential address been published. In the same year he was appointed Contributing Editor of the *Geographical Review.*

At the April 29, 1938, meeting of the Section on Oceanography of the American Geophysical Union in Washington, D. C., Joerg read a paper on "The Representations of Suboceanic Relief on Maps of Intermediate Scale." His remarks were directed principally toward the bathymetry shown on the International Map of the World and a recommendation that Theodor Stocks' proposed modifications appeared worth consideration for adoption by the International Map Committee.

In 1938 Joerg was appointed by the Archivist of the United States to serve as his representative on the United States Board of Geographical Names.[44] This came to be one of his most cherished activities and one to which he felt he had perhaps made some of his most lasting contributions. He served this Board in several capacities and gave much official and personal time to the requirements. Recognition of his abilities came in 1940 when the Secretary of the Interior, Harold L. Ickes, appointed him chairman, a position held until July 1947 when the Board was reconstituted as an expanded permanent office in the Department of the Interior.[45]

[42] For details as to these records see *Guide to the Records in the National Archives,* Washington, 1948, and a *Preliminary Inventory of the Cartographic and Related Records in the Cartographic Records Branch,* the National Archives, 1954. For detailed finding aids to these records consult the Cartographic Records Branch.

[43] This manuscript is among the permanent records of W. L. G. Joerg on file in the Cartographic Records Branch, the National Archives, Washington, D. C.

[44] For details concerning Joerg's associations with this agency see the permanent records in the Division of Geography, Department of the Interior, Washington, D. C. and Mr. Joerg's official file in the National Archives, Washington, D. C.

In recognition of his lasting contributions he received a letter of commendation from Julius A. Krug, Secretary of the Department of the Interior. Mr. Joerg's work on the geographic names of the Antarctic has been recognized in the naming of Joerg Plateau, the high land south of the Filchener-Lassiter Shelf Ice, in his honor.

During November and December of 1938 and January 1939, he represented the Archivist at a conference of officers of Federal agencies selected to prepare for an "International Exhibit of Polar Exploration to be held in Bergen, Norway, in 1939," and was a member of the committee responsible for preparing a plan and budget and reporting to the Department of State. His special talents in cartography were utilized during the period 1938–1942 as a member of the "Special Committee on the Definition of Surveying and Mapping Terms" of the Federal Board of Surveys and Maps. Joerg was one of the most conscientious contributors to the activities of and served in many different capacities on the Board until its termination in 1942.[46] In the same year he was appointed chairman of the United States committee responsible for the preparation of the United States exhibit at the International Geographical Congress in Amsterdam during that summer.

On June 21, 1939, he read a paper on "The Content and Significance of the 'Atlas to Accompany the Official Records of the Union and Confederate Armies'" before the American Military Institute in Washington. This was based largely on the primary records that were recently accessioned by the National Archives. In this unpublished paper he deals with the mode of presentation, method of selection, and form of reproduction, of the maps.[47] He notes the value of this series of maps to geographers, especially as to soil erosion studies, urban land use, and historical geography generally.

At the Seventh Assembly of the International Union of Geology and Geophysics in Washington, on September 12, 1939, he read a paper on "The Representation of Bathymetry on the International Map of the World." In recognition of his contributions in this field he was appointed to that organization's Committee on the Criteria and Nomenclature of the Major Division of the Ocean Bottom. This was followed on October 14 by a paper on "Archival Maps as Illustrated by those in the National Archives," read at the Third Annual Meeting of the Society of American Archivists in Annapolis, in which paper Joerg described the functions and policies of the National Archives and discussed the administration and use of the archival map collection. During the period 1939–1941 he contributed frequently to the United States Coast Guard Ice Patrol, especially as to the methods of recording ice observations and the preparation of appropriate maps showing the results of those observations.

Late in the same year he served in an advisory capacity to the United States Civil

[45] Meredith F. Burrill, "Reorganization of the United States Board on Geographical Names," *Geographical Review,* XXXV: 647–652.

[46] The permanent records of this agency (abolished in 1942) are in the National Archives, Washington, D. C.

[47] This manuscript is among the permanent records of the Cartographic Records Branch, the National Archives, Washington, D. C.

Service Commission in the preparation of an examination for the position of Junior Professional Assistant Geographer. This is significant because it was the first time in the history of the Civil Service that a single and uniform test was provided for candidates in the geographic profession. Similar services were given on several occasions during the following decade.

He was appointed by the Archivist to represent the National Archives at the Eighth American Scientific Congress meeting in Washington, May 10–18, 1940 and, in the *Proceedings* of that Congress, published an article on "The Lafora Map of the Frontier of New Spain in 1766–67 in the National Archives." This paper was based on the discovery of the valuable map among the records in the Division of Maps and Charts and on a considerable amount of research regarding its genesis in the Archivo Nacional in Mexico City and migration to the United States.

During the period 1940–1945, Mr. Joerg was frequently consulted by members of the Armed Forces and defense agencies on mapping techniques, methods of graphic representation and the regional geography of the polar regions and Europe.[48] In recognition of his contributions he was given letters of commendation and otherwise honored. Early in the war he was appointed chairman of a committee of the Association of American Geographers responsible for appraising the qualifications of geographers who might be called upon for emergency war service. This committee also acted as a liaison between the Division of Geology and Geography of the National Research Council and the National Roster of Scientific and Specialized Personnel. This led to his appointment in 1942 as chairman of the subcommittee on the census of professional geographers in the United States in the Division of Geology and Geography of the National Research Council. In his report in December 1943 he said that the major objective of his committee was

> . . . to gain and present a picture of the present status of geography in the United States to the extent that it is revealed by the census, an objective that is wholly distinct from the utilitarian purpose of placing appropriate geographical personnel in Government war agencies that the questionnaires have so admirably aided.[49]

In addition to serving as a basis for valuable personnel information during the war the questionnaires served as a source for a paper by Joerg on "The Statistical Structure of American Professional Geography in 1943" read at the annual meetings of the Association of American Geographers in Columbus in 1946. This paper

> . . . consists of an analysis of statistical data relating to about 800 persons with training in geography, and attempts to interpret some of the significant facts and trends disclosed. It is accompanied by a diagram in the form of the customary pyramid diagram of census vital statistics, distributed by age levels, that indicates training by type of degrees conferred, and in the case of six leading institutions, by name of conferring institution.[50]

In the spring of 1942 he gave the first of a series of annual lectures (to 1949)

[48] The permanent files covering Joerg's activities are among the records of the Cartographic Records Branch, the National Archives, Washington, D. C.

[49] See his report as chairman of the subcommittee in the files of the Division of Geology and Geography, National Research Council, Washington, D. C.

[50] *Bibliography, I,* 1947, p. 39.

on archival administration in relation to cartographic records, for an American University course on the history and administration of Archives.[51] Early in the year he was appointed to assist the Hispanic Foundation of the Library of Congress in recommending outstanding American books in geography for translation into Spanish and Portuguese for distribution in Latin America.

A lecture on the "Work of the Division of Maps and Charts in the National Archives," given at the October 3, 1944, meeting of the Geography and Map Group of the Special Libraries Association served to acquaint special libraries in the Washington area with the plans and policies of this new archival profession and how a geographer qualifies to serving it.

In 1945 he was appointed to serve on a committee of five to draft recommendations as to the advisability of establishing in the United Nations Organization an agency for the improvement of basic mapping throughout the world and for the international support and encouragement of such mapping.[52] These associations were stimulating and many of the committee's recommendations bore fruit. Mr. Joerg's interests in cartography found particular emphasis in its application to New World needs. In 1945 he represented the Archivist of the United States on the newly appointed United States Advisory Committee on Cartography to discuss the Caracas meeting of the Pan American Institute of Geography and History. This was the beginning of similar associations with this committee that lasted until his death and was among his most favored interests as well as fruitful contributions.

When in 1946 it became apparent to many geographers that the schism which existed between the Association of American Geographers and the American Society of Professional Geographers was needless and injurious to the profession, Mr. Joerg was named one of three representatives of the Association of American Geographers to meet with an equal number of geographers from the American Society of Professional Geographers to explore the problem with a view to recommending the merging of the two. The report of the joint committee was presented at the annual meetings in December 1947 and, significantly, in 1948 the members of the two organizations voted to amalgamate. Mr. Joerg's part in the move to bring the two organizations together was large, yet for the most part little known.

In October 1946 he was the invited speaker at a meeting of the graduate students of the Department of Geography at the University of Maryland, the subject of his address being "Opportunities in Historical Geography." This was his first meeting with the Department in the capacity of consulting professor of historical geography; much of his spare time during the next four years was given to advising gradu-

[51] His outline of the lectures, exhibit of maps, and list of sources used are on file among the permanent records of the Cartographic Records Branch, the National Archives, Washington, D. C.

[52] An outgrowth of these efforts was the establishment within the United Nations Organization of a Cartographic Office and the periodic issuance of subject publications, notably, *Modern Cartography, Base Maps for World Needs* (UN publication No. 1949. I.19) and "World Cartography, published annually as a report upon activities, progress, and plans in the field of cartography throughout the world" (Volume 1, 1951).

ate students working on advanced degrees in the preparation of their theses. In this work he was happy and confident that at long last perhaps historical geography was coming of age. All whose privilege it was to have him as adviser are loud in praise of his ability and were honored by his meticulous attention to their problems.

It is perhaps significant that the last professional paper he prepared and read before a scientific organization was on a subject close to his heart and one in which he had become proficient and a universally recognized specialist. This was his paper on "One Hundred Years of the Official Mapping of the United States," read before the Tenth Meeting of the American Congress on Surveying and Mapping, in Washington in June 1950, and subsequently published in that organization's journal.

Shortly after Mr. Joerg's death there was issued as an official facsimile publication of the National Archives "Washington's Official Map of Yorktown." This is a product of considerable careful and systematic research and identification by Joerg and members of his staff, of a manuscript map prepared by the French Engineer, Jean Baptiste Gouvion, in 1781, and thought to have been lost until discovered among records transferred from the State Department to the Cartographic Records Branch in the National Archives. Mr. Joerg, in addition to collaborating in the research, prepared the descriptive text that accompanied the map—an excellent example of scholarly research in historical geography.

Shortly after Mr. Joerg's death the American Geographical Society published a volume of *Readings in the Geography of North America . . .* (1952). Included within this publication is a reprint of Joerg's paper (1936) on "The Geography of North America: A History of its Regional Exposition." Accordingly there was an almost immediate response to his modest hope that "if I am remembered for anything I may have left to geography I hope that it will be my publications."[53]

As geographers and kindred scientists read more of the published fruits of this man's knowledge so, indeed, will grow their respect for his stature and genius as one of the leading geographers of the first half of the twentieth century. They will recognize in these publications his modesty and impeccable honesty, his trust in human beings, and a respect of their point of view, and particularly a warmth and understanding that won for him a multitude of friends.

BIBLIOGRAPHY

As an editor and particularly as a member of the staff of the American Geographical Society, Mr. Joerg frequently contributed unsigned reviews and short-length articles on subjects in his fields of specialization, notably the polar regions, regional geography of North America, cartography, historical geography, and land planning to the *Bulletin* and the *Geographical Review*. The number of these unsigned contributions must be large, as indeed so also is the number of similar unsigned contributions he made to publications of other professional societies

[53] This paper appeared in the *Geographical Review*, XXVI: 640–663. Mr. Joerg was unknowingly prophetic when three days before his death he made these remarks to the writer of this paper as we held one of our frequent after-hours discussions in the offices of the Cartographic Records Branch in the National Archives.

and organizations. An examination of the principal geographical literature, especially the periodicals published during the period 1910–1952, reveals the following significant signed articles and books for which Mr. Joerg was responsible and those to which he as editor made major contributions.

I. REVIEWS, ARTICLES, AND BOOKS PUBLISHED
(Arranged according to date of publication)

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1909. "The Seventeenth Meeting of German Geographers," *Bulletin of the American Geographical Society,* XLI (1909): 496–502.

1910. "Geography in Germany," *Bulletin of the American Geographical Society,* XLII (1910): 287–288.

"The Tectonic Lines of the Northern Part of the North American Cordillera," *Bulletin of the American Geographical Society,* XLII (1910): 161–179.

1911. "The Absence of Religious Conceptions Among the Kubus of Sumatra," *Bulletin of the American Geographical Society,* XLIII (1911): 686–687.

"Early Dutch Immigration to the United States," *Bulletin of the American Geographical Society,* XLIII (1911): 917.

1912. "On the Proper Map for Determining the Location of Earthquakes," *Annals of the Association of American Geographers,* II (1912): 47–54.

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1914. "The Subdivision of North America into Natural Regions: A Preliminary Inquiry," *Annals of the Association of American Geographers,* IV (1914): 55–83.

"Col. (Theodore) Roosevelt's Exploration of a Tributary of the Madeira," *Bulletin of the American Geographical Society,* XLVI (1914): 512–519.

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1915. "The Geographic Center: Its Definition and Determination," (abstract in) *Annals of the Association of American Geographers,* VI (1915): 127–128.

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1915. "Cartography (Annual Review of the Progress in American Cartography)," *The American Year Book . . . , 1914*, pp. 605–607, New York, 1915.

1916. "Cartography (Annual Review of the Progress in American Cartography)," *The American Year Book . . . , 1915*, pp. 607–608, New York, 1916.

1917. "Relief Models as a Source of Information for the Geography of the United States," (abstract in) *Annals of the Association of American Geographers*, VII (1917) : 78–79.
"Cartography (Annual Review of the Progress in American Cartography)," *The American Year Book . . . , 1916*, pp. 607–609, New York, 1917.
"European War Maps," *Geographical Review*, IV (1917) : 51–54.

1918. Responsible for the preparation of maps in *The Chronicles of America Series*, New Haven, 1918, volumes 3 (one map), 4 (one map), 5 (one map), 10 (one map), and 26 (one map).
"Cartography (Annual Review of the Progress in American Cartography)," *The American Year Book . . . , 1917*, pp. 591–593, New York, 1918.

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1939. "The Representation of Bathymetry on the International Map of the World." Paper read at the Seventh Assembly of the International Union of Geodesy and Geophysics in Washington, D. C.

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"Archival Maps as Illustrated by those in the National Archives." Paper read at the Third Annual Meeting of the Society of American Archivists in Annapolis, Maryland.

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1946. "The Statistical Structure of American Professional Geography in 1943." Paper read at the Thirty-Sixth Annual Meeting of the Association of American Geographers in Columbus, Ohio.

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WILLIAM HERBERT HOBBS, 1864–1953

ROBERT BURNETT HALL

WILLIAM Herbert Hobbs, Past President of the Association of American Geographers and Professor Emeritus and former chairman of the Department of Geology at the University of Michigan, died at the age of 88 in Ann Arbor on January 1, 1953, following a brief illness. In his passing the geographical profession lost one of its staunchest supporters, the geological profession one of its most active workers, and the United States of America one of its most loyal and zealous citizens. World-renowned as a scientist, explorer, and teacher, his wide range of interests, his unquenchable curiosity and his truly amazing energy, enthusiasm, and activity were long a source of inspiration, and even of awe, to his colleagues and students. Loyal and steadfast in friendship, ever happy and enthusiastic in controversy, he was at heart a valiant warrior. His was a colorful and positive personality.

Dr. Hobbs was born on July 2, 1864, in Worcester, Massachusetts, the son of Horace and Mary Parker Hobbs. School was from the beginning a source of delight. He showed particular aptitude in drawing and design and this gave direction to his earlier career and doubtlessly influenced his life long interest in the graphic arts. He attended the Worcester Academy and later the Worcester Polytechnic Institute, studying design and acquiring a basic groundwork in mathematics. He received the Bachelor of Science degree in 1883.

The year following graduation was spent in teaching in the public schools of Boylston and Auburn and in taking private lessons in oil and aquarelle painting. In the fall of 1884 the decision was made to take up graduate work at the Johns Hopkins University. There he studied under a number of distinguished and inspiring teachers and acquired a sound foundation in chemistry and physics. He decided to specialize in mineralogy and petrography. The summer of 1886 was spent working under Pumpelly in the Green Mountains and the Berkshire Hills of Western New England as a volunteer field assistant with the United States Geological Survey. Two terms of the following year were spent at Harvard where he came under the influence of Shaler and Wolff. Returning to Johns Hopkins he received the degrees of A.M. and Ph.D., both in June 1888. On July 2, of the same year he sailed for Europe to further his studies at Heidelburg University, then famous for its work in petrography. Formal studies were supplemented by extensive field trips in Italy, Switzerland, and Germany, enthusiastically viewing volcanoes in eruption and collecting geological specimens.

The next chapter in his career involves his years at the University of Wisconsin. He was appointed Instructor in Mineralogy and Metallurgy and Curator of the Geological Museum in 1889, under C. R. Van Hise as Chairman of the Geology Department and T. C. Chamberlain as President of the University. He was pro-

moted to the rank of Assistant Professor of Mineralogy and Petrology in 1891 and in 1900 attained the rank of Professor. By 1905 his interest in dynamical and structural geology had so developed that he resigned from Wisconsin where no such teaching position was open. These years at Wisconsin, as all years in Dr. Hobb's life, were active ones. They involved teaching a variety of courses, museum and editorial work, and extensive field studies. He continued his summer field work in New England with the United States Geological Survey. In 1901 his study of the Pomperaug Valley was published by the Survey and a considerable controversy followed over the intricacy of the fault net portrayed. Dr. George Otis Smith, then Director of the Survey, felt it necessary to visit the area and was convinced that Dr. Hobbs' findings were valid. This interest in fault patterns and density long remained with him and led to investigations in distant parts of the world. Another study on a somewhat controversial subject appeared in this same period entitled "Diamond Field of the Great Lakes," demonstrating that the occasional diamonds found in the Great Lakes' region were brought in by the glaciers and were not "planted" African ones as had been contended. In 1891 he was elected a Fellow of the Geological Society of America and began his long years of active service to that organization. In 1897 he went as a United States Government delegate to the Seventh International Congress of Geology at St. Petersburg. He joined the Finland excursion of the Congress and afterwards travelled widely over Europe.

While at Wisconsin, on June 23, 1896, Dr. Hobbs was married to Mrs. Sara Kimball Sale of Green Bay, Wisconsin. To this union one daughter was born, Winifred, who became the wife of the late Professor Joseph M. Lincoln. Personal sorrow came to Dr. Hobbs, but he faced it bravely and did not allow it to deflect him from the tenor of his way. His wife, to whom he owed so much, died suddenly in 1940 and his daughter, to whom he was devoted, died in 1948. A grandson and a granddaughter survive as does one greatgrandson who bears Dr. Hobbs' name.

The year of 1905–06 was taken on sabbatical leave. He travelled widely in Europe, spending considerable time in Spain, rushing to Italy to view the results of the great Calabrian earthquake, conferring in Vienna with Professor Edward Suess, corresponding and talking with the Viscount de Montessus de Ballore, rushing again to Italy to study Vesuvius in eruption, and journeying to Morocco.

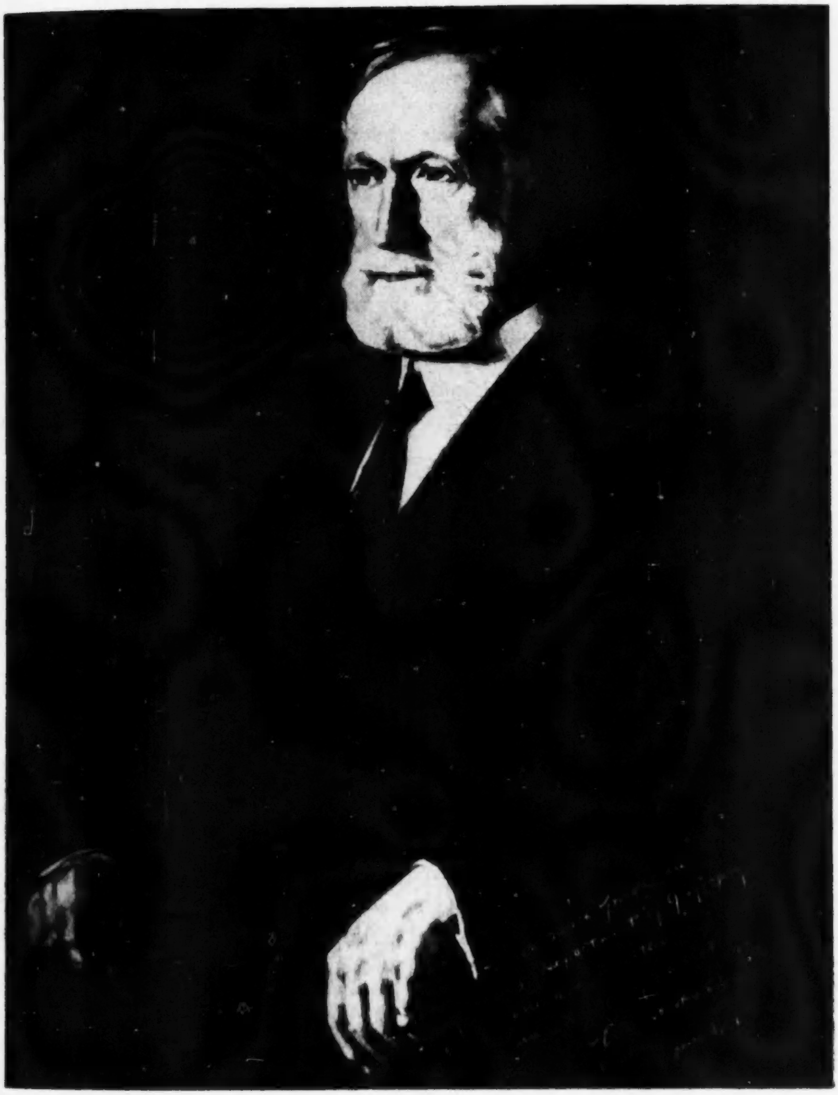
Dr. Israel C. Russel died in May 1906 and the chair of Geology thus vacated at the University of Michigan was offered to Dr. Hobbs in August of that year. He accepted and took over his new duties the following month. This had been a one-man department and the space available consisted of one small office and some cluttered storerooms. There was not even an assistant to advise as to what had gone before. Dr. Hobbs found eleven courses in geology listed—all presumably to be taught by him. With his customary vigor, enthusiasm and foresight, he pitched into the job and in the years that followed built one of the outstanding geology departments in the country. He held the position for twenty-eight years to become Professor-Emeritus in 1934. He saw, in those years, the department grow to ten

permanent staff members and student enrollment increased from 131 to 1,035.

In the course of this he brought into being the Department of Geography at the University of Michigan. Dr. Carl O. Sauer was invited to join the staff in 1915 and ably built the groundwork for the later independent department. He remained as head of the geography work within the Geology Department until 1923 when he resigned to accept his present position at the University of California. Dr. K. C. McMurry succeeded him and the struggle for an independent department came to a head. In this Dr. Hobbs took the leadership and eventually overrode the opposition. In the years that followed he gave every official help to the new department and was the warm and personal friend of each member of its staff. The Department of Geography at the University of Michigan is proud to display the photograph here included and the inscription it carries which reads "With much pride in our Department of Geography which I had the privilege and honor of initiating. William H. Hobbs, Ann Arbor, Jan. 5, 1935."

During these long years at Michigan it is difficult to determine his greatest achievement. He was an outstanding teacher and to the year of his retirement enjoyed conducting a large elementary course. He was always a sympathetic and interested counselor to students at all levels. The success of his graduate students testifies to his able guidance. The ever expanding horizon of his research carried him to every continent, to the Pacific Islands, and to Greenland. He brought stimulating new ideas to many geological and geographical fields: the growth of mountains, the work and nourishment of glaciers, the origin of coral atolls, the glacial anticyclone, the origin of earthquakes, desert weathering, the processes of vulcanism, and geographical exploration and discovery—these are but some of the important problems to which he contributed stimulating ideas. He was never adverse to controversy; indeed, he took a delight in it, but the issues for which he contended were neither narrow nor limited. His arguments were based on scientific, not personal grounds, and it was possible to contest vigorously with him and yet retain his friendship and respect.

His intense interest in research did not waver to the very end. Visitors during his final illness were asked to find this article or that which had bearing on subjects on which he planned to write when once out of bed. During his long and productive years he published some 400 articles and 15 books, some of which were written in German and a considerable number of which have been translated into foreign languages including French, German, Hungarian, Italian, Japanese, Spanish, and Rumanian. Most of these were in the field of geology, or closely related subjects, but his facile mind also encompassed far horizons. It is interesting to note such titles as: "Art as the Handmaid of Literature," "Japan's Navy in the War with China," "The Length of Service Pensions of the Carnegie Foundation," "The Island of Yap and Its People," "The New Steel Industry of Australia," "History Teaching and American Citizenship," "The Northern Flying Route to Europe," "The Track of the Columbus Caravels in 1492," "Outfit for a Camping and Tramping Trip," "The Problem of a New Transisthmian Canal," and a booklet, "Verse."



WILLIAM HERBERT HOBBS

Research into polar problems absorbed much of his interest in later years. After he had passed his sixtieth birthday he organized and led three expeditions to Greenland in the period between 1926 to 1928. He returned each time from the rigors of Arctic life with undiminished vigor and increased enthusiasm. He was an ardent supporter of Robert E. Peary's claims to discovery of the North Pole and played an important and energetic part in discrediting Dr. Frederick A. Cook. He was a friend of most of the contemporary polar explorers and over the years brought most of them to the University and to his home. His writings on polar problems were varied and many and included such subjects as polar anticyclones, formation of ice caps, visibility in polar areas, morphology of glaciers, pack-ice, polar loess, and polar discovery and exploration. He clashed violently with certain British authorities over discovery in Antarctica.

He had a flair for biography and in the course of the years wrote many biographical memoirs and notes and published three book-length biographies on Leonard Wood, Robert E. Peary, and explorers of the Antarctic. His latest book was his autobiography, *An Explorer-Scientist's Pilgrimage*, in 1952. It is an inspiring and altogether fascinating story and has been drawn on freely in the preparation of this memorial.

Retirement in 1934 meant only more time for research and between that date and his death he produced well over 100 publications, including four sizable books. It was during this period that he held the Presidency of the Association of American Geographers. He continued to travel as of old, attending international scientific conferences, giving lectures abroad, and continuing field studies. During World War II when the gasoline and tire shortage made auto transportation impossible he hitchhiked through Oregon to study the channeled scab lands. He was truly ageless and his erect carriage, vigorous and youthful stride, exuberant enthusiasm, and wide interests remained unchanged throughout the years.

In addition to the many national and international honors and offices accorded Dr. Hobbs, it is possible that more geographical features of the earth's surface have been named in his honor than is true of any other living person. These number a dozen and include five glaciers, three mountains, and a number of other physical features.

It seems appropriate here to summarize Dr. Hobbs' major contributions to geographical knowledge and the geographical profession. A considerable portion of his many publications were in the field of the broader geography, and many others had a strong geographical flavor. He was long an active member of the Association of American Geographers and was its distinguished President in 1936–37. He initiated and ever after gave strong and unfailing support to the Department of Geography at the University of Michigan. He was friend and wise counselor to many young and aspiring geographers. He supported the interests of geography wherever he met them.

THE RELIABILITY FACTOR IN THE DRAWING OF ISARITHMS*

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ANYONE who has constructed isarithmic maps has at one time or another been faced with the question as to how closely his isarithms should fit the plotted data on which they are based. Quite properly, closeness of fit is in large part a matter of judgment in the sense that the investigator, knowing the factors that influence the values of the variable, will apply this knowledge in making decisions as to the location of a single isarithm or a group of isarithms. An obvious example of such exercise of judgment is found in the drawing of isohyets for a plains region that includes within its borders a prominent isolated mountain. Because it is known that such a mountain usually produces increased rainfall on its slopes through forced lifting of moisture-bearing air, an investigator drawing an isohyetal map for such an area would quite properly bunch the higher-valued isohyets around the mountain rather than space them in direct interpolative manner with respect to lower-valued rainfall observation points on the surrounding plain. Similarly, on isarithmic maps pertaining to cultural factors, as on a map showing mean income or land in crops, an investigator would apply his judgment in the bunching of isarithms in zones where he had reason to believe unusually rapid transition would occur.

The fitting of isarithms to plotted data is not, however, simply a matter of understanding the factors that influence a variable and of applying this understanding in a judgment sense. There is also the problem of the reliability of the data themselves as that reliability relates to the precision with which the isarithms should fit the plotted values. To take an extreme and hypothetical example, if there is a 50 per cent chance that any plotted value may be as much as 100 per cent in error, then clearly a close fitting of the isarithms is not warranted. This study examines the relationship between the reliability of plotted data and the degree of precision that should reasonably be exercised in the drawing of isarithms to fit the data. A simple statistical method is developed for estimating goodness of fit of isarithms and this method is applied for illustrative purposes to the drawing of a map showing mean July temperatures in the state of Kansas.

* This paper, which was presented at the annual meetings of the Association of American Geographers at Cleveland, April 1953, is based primarily on a concept worked out by the author several years ago. At that time, the author was aided in his formulation of the method by several fruitful discussions with Dr. George S. Benton, now of Johns Hopkins University. The author wishes to acknowledge Dr. Benton's help while at the same time making it clear that any errors of omission or commission that may appear herein are chargeable against the author rather than against Dr. Benton.

DEFINITIONS

Despite attempts at standardization, there is still some diversity in the terminology used to describe various kinds of maps on which there are lines of constant quantitative value. The term *isarithm* as used here is intended to apply to all maps on which such equal-value lines appear. Thus, isarithmic maps are intended to include both isopleth maps and isometric maps as defined by J. K. Wright.[1] The term *reliability* is used here in the statistical sense, to refer to the degree of confidence that can be placed in the accuracy of a given value. The various factors that have a bearing on reliability are considered and discussed below. The term *population* is also used in a statistical sense, to refer to the entire body of items whose areal variations are to be represented on the isarithmic map. The population may coincide with the data plotted on the map or it may be larger than the plotted data, as in instances in which the plotted data constitute a sample of a larger body of data.

RELATED INVESTIGATIONS

There exists a moderately extensive literature that pertains to the construction of isarithmic maps. Much of this literature is concerned with such subjects as selection of isarithmic intervals and the location of control points on maps of the isopleth type.[2] However, although numerous investigators have recognized the fact that the reliability of data has a significant bearing on the problem of drawing of irarithms, no technique for attacking this problem has thus far been worked out. The attitude that has usually prevailed is that it is impracticable or impossible to consider the reliability factor.[3] While it is true that a careful statistical determination of reliability is usually laborious and sometimes impossible, it is equally true that in a great many instances the reliability associated with the plotted data that are the basis for an isarithmic map can be estimated with a reasonable degree of accuracy without too great an expenditure of time. Futhermore, there are many useful isarithmic maps that are based on data for which the reliability, at least in a sampling sense, has already been calculated and is therefore available to the investigator at no cost in time or labor. Thus many statistics in the 1950 U.S. Census of Agriculture were obtained on a sampling basis and where such is true the sampling error associated with these statistics is

[1] John K. Wright, "The Terminology of Certain Map Symbols," *Geographical Review*, XXXIV (1944): 653-54.

[2] Josef Czekalaski, "La carte isarythmique: sa methode et son degre de precision." [French summary.] pp. 230-234 in "Mapa Izarytmicznaa Obraz Rzeczywisty (Proba Analizy Metody)," *Wiadomosci Skuzby Geograficznej*, VII, No. 3 (1933): 202-234.

Wellington D. Jones, "Ratios and Isopleth Maps in Regional Investigations of Agricultural Land Occupance," *Annals of the Association of American Geographers*, XX, No. 4 (1930): 177 pp.

J. Ross MacKay, "Some Problems and Techniques in Isopleth Mapping," *Economic Geography*, XXVII, No. 1 (1951): 1-9.

Fr. Uhorczak, "La methode isarythmique appliquee aux cartes statistiques." [French summary.] pp. 124-129 in "Metoda Izarytmiczna W Mapach Statystycznch," *Polski Prezeglad Kartograficzny*, IV (1930): 95-129.

[3] *See*, for example, Wellington D. Jones, *op. cit.*, p. 184.

presented. These statistics include data on income, farm facilities, farm equipment, farm labor, and farm management.[4] In either event, whether the reliability must be estimated or whether the figures pertaining to reliability are immediately at hand, much is gained through considering the reliability factor in the drawing of isarithms in all those instances in which the reliability is not unusually high.

FACTORS AFFECTING RELIABILITY

Statistical data of the kinds ordinarily employed in the construction of isarithmic maps may be subject to three kinds of errors that lessen their reliability. They may be subject to observational error, sampling error, or to bias or persistent error, as it is sometimes called. *Observational error* is associated with the method used initially for determining the quantitative values that are the basis of the map. If these values rest on instrumental observations, as in the case of climatological data, there is invariably some observational error associated with the accuracy of the instruments and with the physiological and psychological limitations of the observer. Even where instrumental observations are not involved there is usually some observational error. Thus, statistics pertaining to crop acreage or to crop production are subject to greater or lesser observational error depending upon the method of estimation or measurement that is used in obtaining the initial data.

Sampling error decreases the reliability of the plotted data whenever the final map is intended to represent a larger population than is embodied in the plotted data themselves. For example, a map of mean precipitation, not limited as to years, involves sampling error since it is based upon statistics for a relatively small number of years and these statistics are therefore only a sample of the total population. Sampling error is also present in instances in which the fundamental data are collected on a sampling basis, as in the U.S. Census data referred to above.

Bias or *persistent error* may enter and affect the reliability of the data in a number of different ways. If the data rest on a counting of items as, for example, heads of cattle or number of persons, there is usually a bias such that the numbers are slightly too low because the chances of counting a given individual twice are far less than the chances of omitting an individual from the count. Where the data rest on instrumental observations the instruments may be biased in one direction or another. The factor of bias is often exceedingly difficult to discern and to estimate but in some instances, at least, the bias factor is extremely important quantitatively and if it is not taken into account the resulting map may show values that are very much too high or very much too low.

METHOD FOR CALCULATING THE EFFECT OF UNRELIABILITY ON DRAWING OF ISARITHMS

There are five fundamental steps in the calculation of the effect of unreliability upon the drawing of isarithms. First, the fundamental data must be examined and

[4] *See*, e.g., *U. S. Census of Agriculture, 1950*, "Indiana, Counties and State Economic Areas," U. S. Department of Commerce, Government Printing Office, Washington, D. C., pp. ix and 275–6.

estimates or calculations must be made to determine the magnitude of all the principal sources of unreliability. Secondly, the data must be corrected in a direct manner to compensate for bias. Thirdly, the standard error must be computed in terms of the observational error and the sampling error. As the fourth step it is necessary to determine what the chances are that any one particular plotted value will be in error by as much as 1, 2, 3, 4, . . . n units solely on the basis of the unreliability of the data. Finally, from this last calculation it is possible to estimate approximately how many of the plotted values should on a chance basis lie outside their proper isarithmic intervals. The procedures and calculations involved in these various steps are illustrated with reference to a specific application that is treated below.

APPLICATION OF METHOD

Suppose it were desired to prepare an isarithmic map showing the mean temperature distribution in the state of Kansas for the month of July. Suppose further that the map conveying this information is to be based upon 25 years of record covering the period 1922 through 1946, and upon the climatological statistics issued by the Kansas State Board of Agriculture.[5] Using this material for illustrative purposes, it is then possible to apply the method outlined briefly above and to do so step by step so as to bring out the effect of application of the method upon the appearance of the resulting map.

The source from which data for this illustration were obtained contains mean July temperature figures by years for 36 observing stations in the state of Kansas. The locations and names of these stations are shown in Figure 1. A distinction is made in Figure 1 between first and second order Weather Bureau stations because there are differences between these two categories of stations in the technique used for computing the mean daily temperature (*see* below).

If mean July temperature figures for the period 1922–46 are calculated for each of the 36 stations, if those figures are entered on a map, and if isotherms are drawn at 1° intervals to fit all of the data, the result is the isarithmic map shown in Figure 2. Examination of this map reveals many irregularities in the isotherms and the presence of two prominent "islands," one in the north central portion of the state and the other in the east central portion. It should also be noted that on this map there is a prominent area in the south central portion of the state in which the mean temperature values are above 82° and that nowhere on the map is there an area in which the mean temperature is below 78°.

SOURCES OF ERROR

It was found upon examination of the fundamental data and upon inquiry into the method of observation that the data upon which Figure 2 is based are subject to observational error, to sampling error, and to bias. Observational error is of

[5] *Report of the Kansas State Board of Agriculture,* "Climate of Kansas," LXVII, No. 285, (June 1948).

three kinds. The fundamental temperature observations are based upon reading maximum and minmum thermometers, a procedure that involves both the errors associated with the physio-psychological limitations of the observer and those associated with the physical limitations of the thermometers themselves. The third source of observational error is that associated with the exposure of the instrument in terms of its location with reference to different kinds of surfaces, obstructions such as trees or buildings, and topography. It is safe to assume that the observational errors

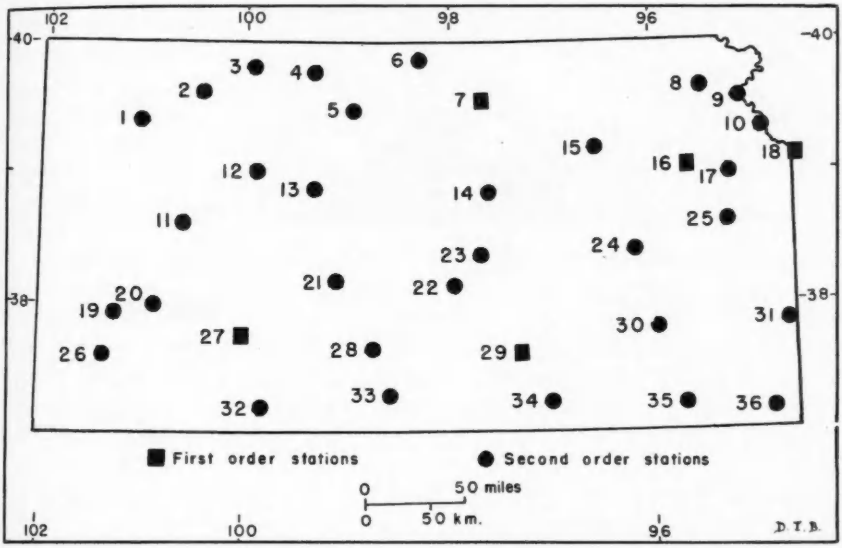

FIG. 1. Index map of Kansas, showing stations for which mean temperatures were calculated as the basis for the preparation of July temperature maps. Key is as follows:

1. Colby	10. Leavenworth	19. Lakin	28. Pratt
2. Dresden	11. Healy	20. Garden City	29. Wichita
3. Norton	12. Wakeeney	21. Larned	30. Toronto
4. Phillipsburg	13. Hays	22. Hutchinson	31. Fort Scott
5. Alton	14. Salina	23. McPherson	32. Ashland
6. Burr Oak	15. Manhattan	24. Emporia	33. Medicine Lodge
7. Concordia	16. Topeka	25. Ottawa	34. Winfield
8. Horton	17. Lawrence	26. Ulysses	35. Independence
9. Atchison	18. Kansas City, Mo.	27. Dodge City	36. Columbus

associated with physio-psychological factors will tend to cancel out and so will not be of sufficient magnitude to warrant consideration here. Such is not true of the errors associated with instrumental limitations. It is estimated that the chances are 50 per cent that any one instrument will be consistently too high or too low by 0.1° to 0.2°, or by about 0.15° F. This means that the mean temperature values at any one station have a 50 per cent chance of being consistently too high or too low by a factor

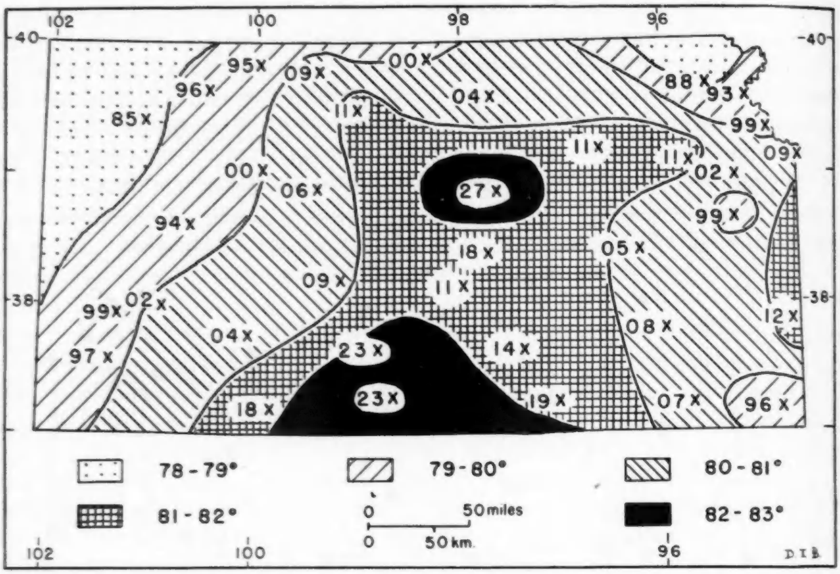

FIG. 2. Mean July temperatures, Kansas, based on uncorrected means for the 36 stations shown in Figure 1, with isotherms drawn to fit data perfectly. Numbers entered on the map show mean temperature in whole units and tenths of a degree; e.g., 11 indicates a mean temperature of 81.1° F.

of approximately 0.1° F.[6] As will be seen below, this error factor can readily be allowed for in conjunction with the sampling error.

As for the third factor, that relating to exposure of the instruments, it is impossi-

[6] Even the most accurate mercury-in-glass thermometer, such as one that is specially calibrated for use in laboratory work, is not reliable to within more than 0.02° F. Maximum and minimum thermometers that are not regularly recalibrated and that are subject to the vicissitudes of repeated handling, certainly are not reliable to within more than 0.15°. For these reasons it is felt that the estimate given above is of the proper order of magnitude. *See* M. F. Behar, "Thermometry," *Handbook of Measurement and Control,* (Pittsburgh: Instruments Publishing Co., 1951), p. 88.

The reasoning and calculations that underlie assigning the value of 0.1° F. to the probable error of the daily mean associated with instrumental bias are as follows. The probable error is 0.15° that any one maximum or minimum thermometer will have a consistent bias in either the positive or negative direction. The mean daily temperature is obtained by averaging the readings of the maximum and minimum thermometers. In some instances the erroneous readings of the two thermometers will tend to cancel each other in their effect upon the mean. Therefore, the mean probable error must be taken as being equal to 0.15° F. divided by the square root of 2; or 0.1° F. Since it is not known whether at any particular station the bias of the mean is positive or negative, and since there is an equal chance of its being one or the other, this instrumental bias factor can not be treated in the same manner as bias factors that operate in the same direction at all stations and must instead be treated in the same manner as a sampling error (*see* below).

ble to estimate the bias introduced by the exposure factor without having access to detailed information concerning each of the 36 stations. Since such information was not available this factor will not be considered here; nor is such consideration necessary to make clear how the method which is the thesis of this study can be applied.

Sampling error is present because the map is intended to represent a mean condition that would hold over a very long period of time, whereas in fact it is based on only 25 years of a record. Computing the sampling error in accordance with standard statistical practices, this error is found to be of the order of 0.6° F. in terms of standard error.[7]

The problem of bias in the fundamental data is an important one. Two possible sources of bias exist: one associated with the methods used for calculating mean daily temperature and the other associated with the fact that there is a long-time trend in the temperature of this region and that hence the data are biased since they are selected from only one particular portion of the trend curve. The first possible source of bias is more easily reckoned with than the second.

At all U.S. Weather Bureau stations it is the practice to obtain the mean daily temperature though averaging the values obtained within the daily period from maximum and minimum thermometers. At first order Weather Bureau stations the maximum and minimum thermometers are read at midnight and the mean temperature that results is in good agreement with the daily mean that would be obtained from analysis of the thermograph curve or from averaging hourly readings. At second order Weather Bureau stations, however, the practice is to read the maximum and minimum thermometers at any one of three times: 8:00 A.M., 5:00 P.M., or sunset. Regardless of which one of these three times the observer selects for taking his readings, there is distinct and pronounced bias in the direction of obtaining mean daily temperture values that are too high. This is particularly true in the case of the 5:00 P.M. reading when, it has been estimated, the bias will be in excess of 1° in the summer months.[8]

[7] The standard error is taken as being directly proportional to the standard deviation of the July means and inversely proportional to the square root of the number of years of observation. The standard deviation of the annual values for the 25 year period covered were determined for three widely separated stations: Colby, Topeka and Medicine Lodge (*see* Fig. 1). These standard deviations were found to be 3.9°, 2.8°, and 2.5°, respectively. The standard deviation for the state as a whole was therefore estimated as being approximately 3°, a figure that agrees reasonably well with the standard deviations derived by A. R. Sumner and shown by him in map form. (*See* Alfred R. Sumner, "Standard Deviation of Mean Monthly Temperatures in Anglo America," *Geographical Review*, XLIII (1953): 55). Dividing the standard deviation of 3° by the square root of 25, the number of years of record, the standard error is found to be 0.6°. The standard deviation might have been determined more accurately and it would have been possible to apply Student's correction for small samples in calculating the standard error, but all that was desired was an estimate and the data did not in any event warrant more accurate treatment.

[8] For a discussion of bias associated with the method of computing mean daily temperatures, *see* W. F. Rumbaugh, "The Effect of Time of Observation on Mean Temperature," *Monthly Weather Review*, LXII, No. 10, (October 1934): 375-76; and F. Z. Hartzell,

The very pronounced bias in the case of the 5:00 P.M. readings results from the fact that the occurrence of an unusually hot afternoon produces a very high 5:00 P.M. temperature, which then constitutes the maximum for the following calendar day even though the following day may be relatively cool. In this way, unusually high temperature conditions have a double effect upon the data. Observations taken at sunset produce bias in a positive direction of an order of magnitude of 0.3–0.4°. Those taken at 8:00 A.M. produce daily means that are too high by an average amount of about 0.2°. In the case of the data being considered here, it was not possible to determine at which of these three times, 8:00 A.M., 5:00 P.M., or sunset, the observations were taken at each of the second order stations. Had this determination been practicable, it would have been worthwhile making. Since such was not practicable, the best that could be done for the purposes of this study was to make one general correction for all second-order stations. It is estimated that the temperature values for the second-order stations are in general too high by an average value of 0.5° and should be corrected accordingly.

The second possible source of bias, that associated with long-term trend in temperature, is exceedingly difficult to evaluate for purposes that are pertinent here. Kincer has shown, conclusively in my opinion, that in the general area of Kansas there has been since 1860 an upward trend of temperature amounting to an average increase of approximately 0.015° F. per year.[9] Even though Kincer's figures are accepted, it is difficult to compensate for them in correcting for bias because to perform such compensation it would be necessary to decide what period was being represented by the mean temperature map. This question is really one of the useful life of the final isarithmic map. If it is to be referred to for a period of many decades as the standard map showing mean July temperature in Kansas, a situation that would be most unlikely, then the map may be thought of as covering a period extending some time into the future; otherwise, it must be thought of as covering a much lesser period. There is also the question as to whether it might be looked upon as a map that shows the mean temperature of Kansas as of 100 years ago. These are imponderables that can only be mentioned here. Fortunately, the bias resulting from trend is not very great and for purposes of this particular study this factor can therefore be ignored.

CORRECTING FOR BIAS

The mean temperature figures for all second order Weather Bureau stations

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"Comparison of Methods for Computing Daily Mean Temperatures," *Monthly Weather Review,* XLVII, No. 11, (November 1919): 799–800. Rumbaugh's study was based on data from Twin Falls, Idaho; Hartzell's, on data from Fredonia, New York. But their results apply generally throughout the United States except, perhaps, at coastal or mountain locations.

[9]See J. B. Kincer, "Is Our Climate Changing? A Study of Long-Time Temperature Trends," *Monthly Weather Review,* LXI, No. 9, (September 1933): 251–59; and J. B. Kincer, "Our Changing Climate," *Transactions, American Geophysical Union,* XXVII, No. III, (June 1946): 342–47.

are estimated as being too high by a factor of 0.5° F., as shown above. To correct for this bias it is necessary only to subtract 0.5° from each of the mean values for the second order stations shown in Figures 1 and 2. If this is done and if a map is then drawn with isotherms at 1° intervals and with the corrected data being fitted perfectly by the isotherms, the result is as shown in Figure 3. It will be

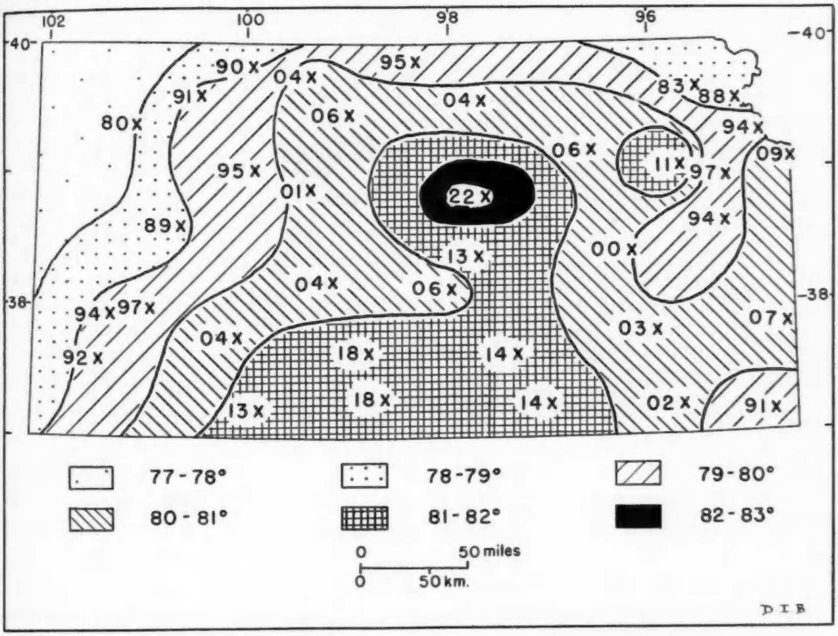

FIG. 3. Mean July temperatures, Kansas, based on mean observations corrected for bias at all second order Weather Bureau stations as shown in Figure 1, with the isotherms drawn to fit the data perfectly. Numbers entered on the map show mean temperature in whole units and tenths of a degree; e.g., 11 indicates a mean temperature of 81.1° F.

noted, comparing Figure 3 with Figure 2, that while both are moderately complex with "island areas" and with isotherms that are far from smooth, there are significant differences between them. For example, on Figure 3 as contrasted with Figure 2, the prominent area with values above 82° disappears from south-central Kansas and there appears a low temperature region, below 78°, in the northwestern part of the state. Other lesser differences will be apparent from comparative examination of the two maps. For purposes of further comparison a second isarithmic map was drawn based on the data corrected for bias. In this second map, which is shown in Figure 4, the isotherms were smoothed out somewhat so that there were four values on the map that were violated. This map is included here because it represents a reasonable degree of generalization that might well be

employed by any climatologist even if he did not take into account error factors other than that of bias. Figure 4 resembles Figure 3 quite closely. The chief differences are that in Figure 4 the isotherms are somewhat more smooth and one of the "island areas," that in northeastern Kansas, has been eliminated.

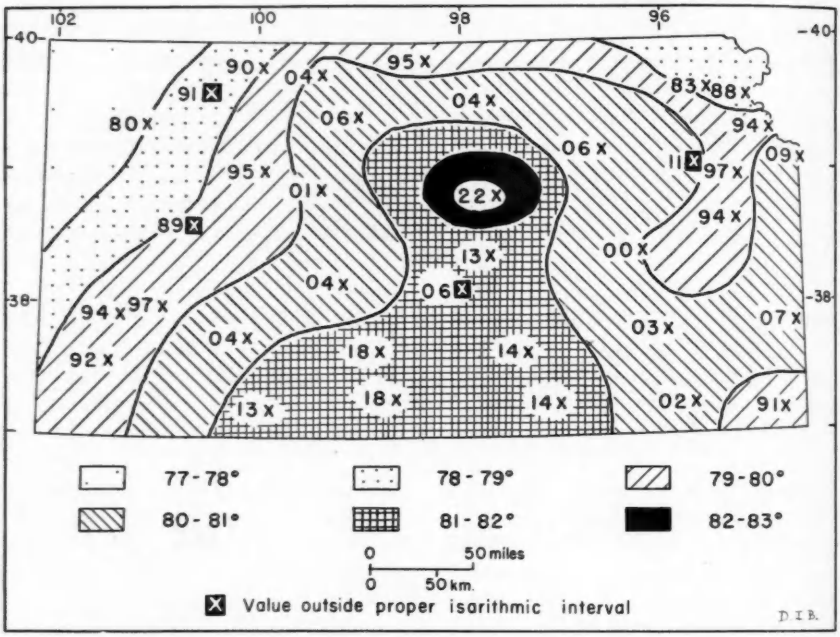

FIG. 4. Mean July temperatures, Kansas, based on mean observations corrected for bias at all second order Weather Bureau stations as shown in Figure 1, with the isotherms slightly generalized. Numbers entered on the map show mean temperature in whole units and tenths of a degree; e.g., 11 indicates a mean temprature of 81.1° F.

CORRECTING FOR SAMPLING AND OBSERVATIONAL ERRORS

As was shown above, the sampling error associated with the mean July temperature values for Kansas on a 25-year period is estimated to be 0.6° F. in terms of the standard error, while the observational error is estimated to be 0.1° F. in the sense that half the observed values would be expected to be 0.1° or more in error because of inaccuracies in observations. The observational error thus estimated is equivalent to a standard error of 0.15° F.[10] When these two standard

[10] The observational error as initially estimated is in terms of probable error; and since the error would tend to be distributed normally in the statistical sense, the standard error is approximately 50 per cent greater than the probable error, or 0.15°F.

error figures are combined, the total standard error is found to be 0.62° F.[11]

Assuming that the total standard error is distributed normally in the statistical sense, it is then possible to calculate from a Normal Curve Table the probability that any one value entered on the map will be in error by 0.1° or more, 0.2° or more, 0.3° or more, etc.[12] The results applying this procedure are shown in Table I.

TABLE I

PROBABILITY THAT A PLOTTED VALUE IS IN ERROR BY $n°$ OR MORE

n (Degrees F.)	Probability of Value Being at Least $n°$ in Error (in per cent)	Probability of Value Being at Least $n°$ Too High or Too Low (in per cent)
0.1	88	44
0.2	78	39
0.3	62	31
0.4	51	25
0.5	43	21
0.6	32	16
0.7	26	13
0.8	19	10
0.9	14	7
1.0	10	5

This table, which is extremely useful in itself in the drawing of isarithms of the right degree of accuracy, may be interpreted in the following manner. There is an 88 per cent chance that any temperature value plotted on the map is in error by at least 0.1° F. and there is accordingly a 44 per cent chance that such a value is specifically 0.1° too high or specifically 0.1° too low. To take another example, there is a 51 per cent chance that any value is in error by as much as 0.4° because of sampling and observational error, and specifically there is a 25 per cent chance it is at least 0.4° too high or at least 0.4° too low. These values can be usefully employed in the drawing of the isotherms since they tell the investigator whether he can or can not reasonably ignore a particular value that appears to be out of place with reference to the surrounding values. For example, in Figure 3 there appears an "island area" in north central Kansas in which the temperature values are above 82°. As will be seen from Figure 3, this island exists because of one value of 82.2° F. The chances are about 40 per cent, however, that this value is too high by a factor of at least 0.2° and since it is a solitary value it is quite reasonable to ignore it and so to eliminate this "island area." To give one more example, the

[11] The standard error of two independent standard errors is equal to the square root of the sum of the squares of the two independent standard errors. Hence, 0.62 represents the square root of 0.6^2 plus 0.15^2.

[12] *See*, e.g., G. Udny Yule and M. G. Kendall, *An Introduction to the Theory of Statistics*, (London: Charles Griffin Co., 1937). p. 553.

79° isotherm that appears in western Kansas in Figure 3 curves sharply eastward to accommodate a plotted value of 78.9°. But as shown in Table I, the chances are almost 50 per cent that this value is 79.0° or higher and therefore it is not reasonable to retain a sharp curve in the isotherm on the basis of the evidence. Other examples can be drawn from studying the relationships between the isotherms and the plotted values as shown in Figure 3.

Data of the kind shown in Table I are in themselves highly useful as a guide in the drawing of isotherms that will fit the data with a proper degree of accuracy. One other line of approach can also be adduced to provide guidance. From Table I it is possible to calculate how many of the values actually plotted on the map would on a 50 per cent probability basis be expected to lie outside the proper isarithmic interval. This information is obtained through listing the plotted values in sequential quantitative order and calculating directly through the application of the information in Table I what the chances are that a particular value will lie above the isotherm that should bound it on one side or below the isotherm that should bound it on the other.[13] This tabulation for the 36 plotted values that have been corrected for bias is shown in Table II. From Table II it will be seen that there is a 50 per cent chance that approximately 12, or one-third, of the values plotted on the map will *not* lie within the apparently proper isarithmic interval. The value 12 is not a magic number. It is not proposed in the application of this method that the isarithms be drawn so that precisely a certain number of values will not conform to the isarithms. Nevertheless, the value 12 can be used in an order of magnitude sense to judge whether isarithms sketched in at the trial stage provide approximately the right degree of goodness of fit.

When the information displayed in Tables I and II is applied in the drawing of isotherms using the values corrected for bias, the result is as shown in Figure 5. Figure 5 is a far more generalized map of the distribution of July temperatures in Kansas than is either Figure 3 or Figure 4, which are based on the same data. This generalization was achieved by ignoring non-significant values in the redrawing of the isotherms. The total result was that ten of the values shown in Figure 5 do not lie within the proper isarithmic interval. This value ten is of the same order of magnitude as the value twelve, which was arrived at through the calculations shown in Table II. Therefore, the isotherms appear to have been drawn with about the right degree of goodness of fit with respect to the data. Furthermore, the values that were violated were with one single exception values that might easily have been sufficiently in error to warrant their being ignored. The one ex-

[13] For example, there is one plotted value of 78.3° that appears on the map (the value for Horton in northeastern Kansas; *see* Figures 1 and 3). The chances are 25 per cent that this value is off by as much as 0.4° in one direction and hence that it is 77.9° or lower and so will lie outside the apparently proper isarithmic interval of 78–79°. The chances are 10 per cent that it is as much as 0.8° in error in one direction and hence has a real value of 79.1 or higher, in which event also it would lie outside the apparently proper isarithmic interval. The total chances are therefore approximately 35 per cent that this value of 78.3° will lie outside its apparently proper isarithmic interval of 78–79°.

ception consisted of disregarding the 79.1° value for Columbus in southeastern Kansas and thus eliminating an island in the category 79–80° (*see* Figures 1 and 3). It is true that statistically speaking the chances are only 1 in 20 that this value is as high as 80.1° (*see* Table II). But there is no physical reason that can be

TABLE II

PROBABILITY THAT A PARTICULAR PLOTTED VALUE WILL LIE OUTSIDE THE PROPER ISARITHMIC INTERVAL AND THE TOTAL NUMBER OF VALUES EXPECTED TO LIE OUTSIDE THE PROPER INTERVAL

Plotted value (degrees F.)	Number of plotted values	Probability of value lying below proper interval (per cent)	Probability of value lying above proper interval (per cent)	Probability of value lying outside proper interval (per cent)	Number of values expected to lie outside proper interval
78.0*	1	5	5	10	0.1
78.3	1	25	10	35	0.4
78.8	1	7	31	38	0.4
78.9	1	5	39	44	0.4
79.0*	1	5	5	10	0.1
79.1	2	39	5	44	0.9
79.2	1	31	7	38	0.4
79.4	3	21	13	35	1.0
79.5	2	16	16	32	0.6
79.7	2	10	25	35	0.7
80.0*	1	5	5	10	0.1
80.1	1	39	5	44	0.4
80.2	1	31	7	38	0.4
80.3	1	25	10	35	0.4
80.4	4	21	13	34	1.4
80.6	3	13	21	34	1.0
80.7	1	10	25	35	0.4
80.9	1	5	39	44	0.4
81.1	1	39	5	44	0.4
81.3	2	25	10	35	0.7
81.4	2	21	13	34	0.7
81.8	2	7	31	38	0.8
82.2	1	31	7	38	0.4
Total no. values:	36	Total expected to lie outside proper interval:			12.5

* This value is taken as lying outside the proper interval only if it is in error by 1° or more.

adduced for the presence of this aberrant low value and perhaps this is a cooperative station at which the maximum and minimum thermometers are read at 8:00 A.M. rather than 5:00 P.M., or sunset, in which event the correction for bias was too great in the negative direction and the chances would not be as low as one in twenty that this value is spurious.

For ready comparison, Figure 6 shows the four maps of mean July temperature in Kansas which have already been discussed separately (Figures 2 through 5). It is immediately apparent from this Figure that through taking into account the reliability of the data there has resulted, as shown in Map D, an exceedingly simple distributional pattern that was not present in the first three maps. Further, more specifically, through taking into account the effect of bias the map finally arrived at shows temperatures that are distinctly lower than those shown in the initial uncorrected map (Map A).

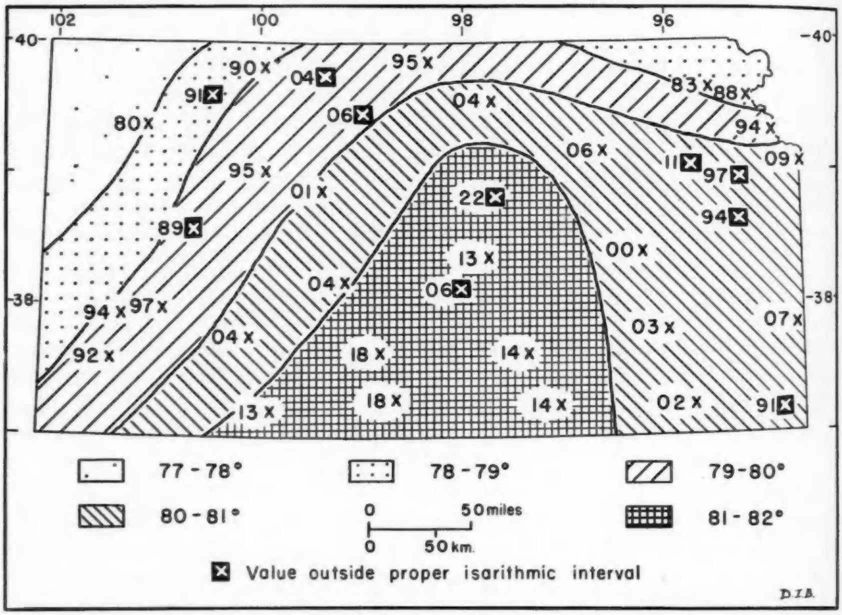

FIG. 5. Mean July temperatures, Kansas, based on mean observations corrected for bias at all second order Weather Bureau stations as shown in Figure 1, with the isotherms greatly generalized in accordance with the degree of reliability of the data. Numbers entered on the map show mean temperature in whole units and tenths of a degree; e.g., 11 indicates a mean temperature of 81.1° F.

It is felt that Map D in Figure 6, unlike Maps A through C, presents a proper picture of the distribution of July temperature in Kansas in view of the gross unreliability of the data. Maps A, B and C, which display temperature variations in great detail, are spurious since these detailed variations can not be relied upon as being real.

Because the method applied here has been presented step by step with considerable explanatory detail, the impression may have been gained that the method is an unusually laborious one that requires considerable time in its application. Ac-

tually, only a few hours' work was involved in making the necessary computations and drawing the revised map, including the time taken to estimate the various sources of error. The most time-consuming portion of the additional work lay in obtaining information on which to base an estimate of the bias factor; but it is believed that this time was well spent in view of the very great bias that was found to be inherent in the fundamental data.

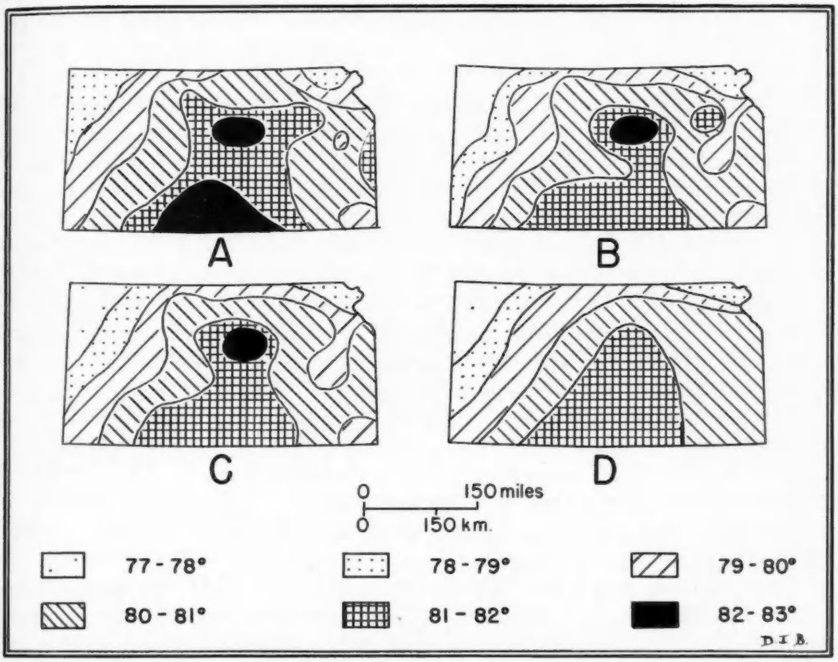

FIG. 6. Comparison of mean July temperature maps, Kansas, based on identical fundamental data. Map A represents perfect isotherm fit to uncorrected means. Map B represents perfect isotherm fit to means corrected for bias. Map C represents slightly generalized isotherm fit to means corrected for bias. Map D represents greatly generalized fit to means corrected for bias, taking into account the unreliability of the data.

APPLICABILITY OF THE METHOD

It is hoped that the method developed and illustrated in the foregoing pages will be found useful in a variety of studies that involve preparation of isarithmic maps. There are, however, limitations to the applicability of the method. In some instances it would not be necessary to invoke the method because the data upon which the isarithmic map is to be based are of a very high degree of reliability. There may be instances in which for statistical reasons the method can not be applied at

least in the form given here. Finally, the variable that is being represented isarithmically may be so strongly influenced by special factors that reliability of data becomes a factor of negligible importance.

The only way in which an investigator can make a reasonable judgment as to whether the method might be advantageously applied is through careful consideration of the fundamental data for the purpose of noting possible sources of unreliability and, where necessary, computing or estimating the magnitude of the error sources. Since in any investigation of a quantitative nature it is essential to form at least some idea as to the reliability of the fundamental data, no extra time is required to judge whether the method should be applied. It should be stressed, however, that even a seemingly minor source of error leading only to a slight degree of lessening of reliability may have a distinct effect upon the degree of closeness with which the plotted points should be fitted through drawing isarithms. If in the drawing of maps of July temperature in Kansas, the only source of unreliability had been the observational error, it would nevertheless have been worthwhile to apply the method. The standard error resulting from the observational error amounted only to 0.15°; but this alone is sufficient to cause the temperature values to be off by as much as 0.1° in about 50 per cent of the cases and to be off by as much as 0.2° in about 20 per cent of the cases. Similarly, in other investigations a seemingly slight source of unreliability may have an appreciable effect upon the degree of precision with which it is reasonable to draw the isarithms.

It is possible that in some instances the method can not be employed in the form given here because the error factor can not be assumed to be distributed normally in the statistical sense with reference to the observed value. If the form of the error distribution is known, it will be possible to develop a method analogous to that developed here, using as a basis for the method not the normal Gaussian curve but a curve of the appropriate kind.

One more limitation of the method requires special mention. There will be instances, as in drawing isohyetal maps for mountainous regions, in which the value that the variable assumes at one or another place within the region is so strongly influenced by special factors such as relief, that the placement of the isarithms is wholly or almost wholly dependent upon that factor alone. In instances such as these, it would be fatuous to apply the method in its entirety, but it might well be useful nevertheless to determine the reliability of the data so that judgments might be made where necessary as to whether completely aberrant values should be modified or ignored.

AN AVERAGE SLOPE MAP OF ILLINOIS

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THE presumed objectivity of statistical methods of comparative terrain studies has a powerful appeal in a science dependent largely on qualitative descriptions of terrain differences. Nevertheless, use of statistical methods of terrain description and comparison has not been widespread. A review of a number of articles and maps on this subject reveals that almost invariably the focus of interest has been on the particular method being experimented with rather than the characteristics of the region to which the technique was applied. The one notable exception in English has been the article entitled "Surface Configuration of the Driftless Cuestaform Hill Land," by G. T. Trewartha and G.-H. Smith,[1] wherein the various methods applied were regarded as tools used to analyze and depict terrain conditions, and the focus of interest was in depicting various characteristics of the terrain, not upon the method itself.

The construction of an average slope map of Illinois was begun to obtain a clearer picture of the differences in terrain conditions in Illinois and to give these differences cartographic expression. As the work progressed and the nature of the maps and the problems in the construction of such maps became clearer, the focus of interest gradually shifted from the characteristics of the terrain to a principal concern with the method itself.

For reasons unknown to the present authors there has been practically no attempt by those who have produced statistical maps to appraise the results of quantitative methods of analyzing and depicting terrain conditions. Smith[2] in his study of the relative relief of Ohio made no direct comments on the utility of the method, but the general tone of the article seems to suggest that he regarded it as a highly useful device for analyzing and depicting terrain conditions in Ohio. Raisz and Henry[3] regarded the Smith method as unsatisfactory for New England's terrain and gave several reasons for this view, though they did not publish a map made by this method for general inspection. They also made a few comments on the value of the method they used in presenting slope conditions in New England. These will be considered later. Two papers have attempted an appraisal of two statistical methods in depicting terrain conditions in Illinois.[4] The results of both these methods were adjudged to be slightly useful in the portrayal of the broadest differ-

[1] *Annals of the Association of American Geographers,* XXXI: 25–45.

[2] G.-H. Smith, "The Relative Relief of Ohio," *Geographical Review,* XXV: 272–284.

[3] Irwin Raisz and Joyce Henry, "An Average Slope Map of New England," *Geographical Review,* XXVII: 467–472.

[4] W. C. Calef, "Slope Studies of Northern Illinois," *Illinois Academy of Science, Transactions,* XLIII: 110–115 and W. C. Calef, "A Relative Relief Map of Illinois," *Illinois Academy of Science, Transactions,* XLV (to be published).

ences in land forms, but to be wholly inadequate for delimiting anything less than the major differences. Since both of these methods had proved disappointing, experiments were initiated in the application of another quantitative method to the same area to see if more satisfactory results could be obained. This paper presents a map of average slope in Illinois made by this latter method and presents the authors' appraisal of three considerations concerning its use: 1) the degree of subjectivity inherent in such a map; 2) precisely what such a map shows; and 3) some judgements on the efficacy of the method.

THE METHOD

The method used in constructing an average slope map of Illinois is a slight variant of the method used by Raisz and Henry in their study of southern New England.[5] They started by attempting to construct a relative relief map of southern New England by the Smith method. Since in their opinion this method proved unsatisfactory for their area, they devised a new method based on average slope conditions. From an inspection of the topographic maps, areas with markedly different spacing of contours were delimited. The work was done in considerable detail. From "three to ten" separate areas were commonly delimited on each topographic sheet. Each of the delimited areas was classified into "categories according to the average density of the contour lines"; this in turn was presumed to be a guide to "average slope" categories.[6]

The only difference between the method used for Illinois and that of the New England study was in the method of determining average slopes. For Illinois, average slopes were calculated for each delimited area by counting contour crossings along various intersecting lines and calculating average slope by means of the Wentworth equation.[7] Just how much difference this makes for an average slope figure in comparison with the method used by Raisz and Henry is difficult to judge, because they do not explain exactly how they applied their contour density scales. It is probable that the differences are not very great and, as Raisz and Henry point out, differences in measurement techniques and in reliability of the contour map data do not significantly change the comparative relationships between areas.

SUBJECTIVE AND NON-QUANTITATIVE ASPECTS OF THE METHOD

Despite their appearance of more or less mathematical preciseness all maps designed to depict quantitative differences in terrain have a high degree of subjectivity. Smith recognized this by stating that his method was "not without some evidences of subjective considerations."[8] This was also implicit in the statement by Trewartha and Smith[9] concerning their relative relief map that "the size of the

[5] *Op. cit.*

[6] *Ibid.*, p. 471.

[7] C. K. Wentworth, "A Simplified Method of Determining the Average Slope of Land Surfaces," *American Journal of Science*, Series 5, XX: 184–194.

[8] G.-H. Smith, *op. cit.*, p. 273.

[9] *Op. cit.*, p. 31.

rectangle for which relief readings are made appears to need adjustment for the degree of coarseness or fineness of the relief pattern."

It has never been made clear how much subjectivity is involved in the making of such maps. We can best approach the subject by a consideration of the process used in making the slope map of Illinois.

All slope or relief maps group the wide variety of slope conditions that occur in any extensive area into slope interval classes: *e.g.*, 0–5 per cent slope, 5–10 per cent, 10–15 per cent, 15–20 per cent, and over 20 per cent average slope; or as used for the map of Illinois, 0–1 per cent slope, 1–5 per cent, 5–9 per cent, and over 9 per cent average slope.

At least three methods may be used for arriving at slope class intervals. The most obvious method is to establish the limits for the class intervals arbitrarily in advance. A 0–5 per cent, 5–10 per cent, 10–15 per cent, etc., average slope class interval would almost certainly be of this type. A second method is to divide a major part of the area into subsections of differing average slopes by an inspection of the topographic maps and then to establish slope class limits that will reveal as many as possible of these differences. A third method is a variant of the second. The map maker can decide which terrain boundaries he most wishes to show, establish his slope class limits so they will clearly reveal those terrain differences which he particularly wishes to depict, and allow the rest of the area to turn out however it may happen to develop.

The importance of the subjectivity of slope class interval selection lies in the fact that the shapes and sizes of areas on the map will vary with every change in the slope interval class. An illustration may make this point clearer.

Suppose that, by any one of the three methods described, we have decided to use class intervals of 0–4 per cent, 4–8 per cent, and over-8 per cent average slope. After inspecting a topographic map in the area we draw a boundary line between two areas of patently unlike slope conditions. When the average slope for these two areas is ascertained we discover that one has an average slope of 4.5 per cent and the other an average slope of 7.5 per cent; hence, they must be included in the same class and our boundary line disappears. If, however, we wish very much to show this boundary we may decide to change this class interval from 4–8 per cent to 5–8 per cent. Shortly thereafter, most certainly, we will delimit two unlike areas only to discover that one is far under 5 per cent and the other only slightly under 5 per cent so that once again we are forced to group together two areas that are significantly different.

The foregoing is true of all statistical maps of terrain elements. The limits and number of the classes selected will cause certain boundaries to appear, and certain areas to take shape, but the likelihood is that it will conceal more differences than it reveals. If, for example, on the slope map of Illinois (Fig. 1) the lowest class interval used had been 0–2 per cent instead of 0–1 per cent average slope the area of white in eastern Illinois would have been greatly enlarged; most of the stippled area in that section would have disappeared. Also, several small white areas would

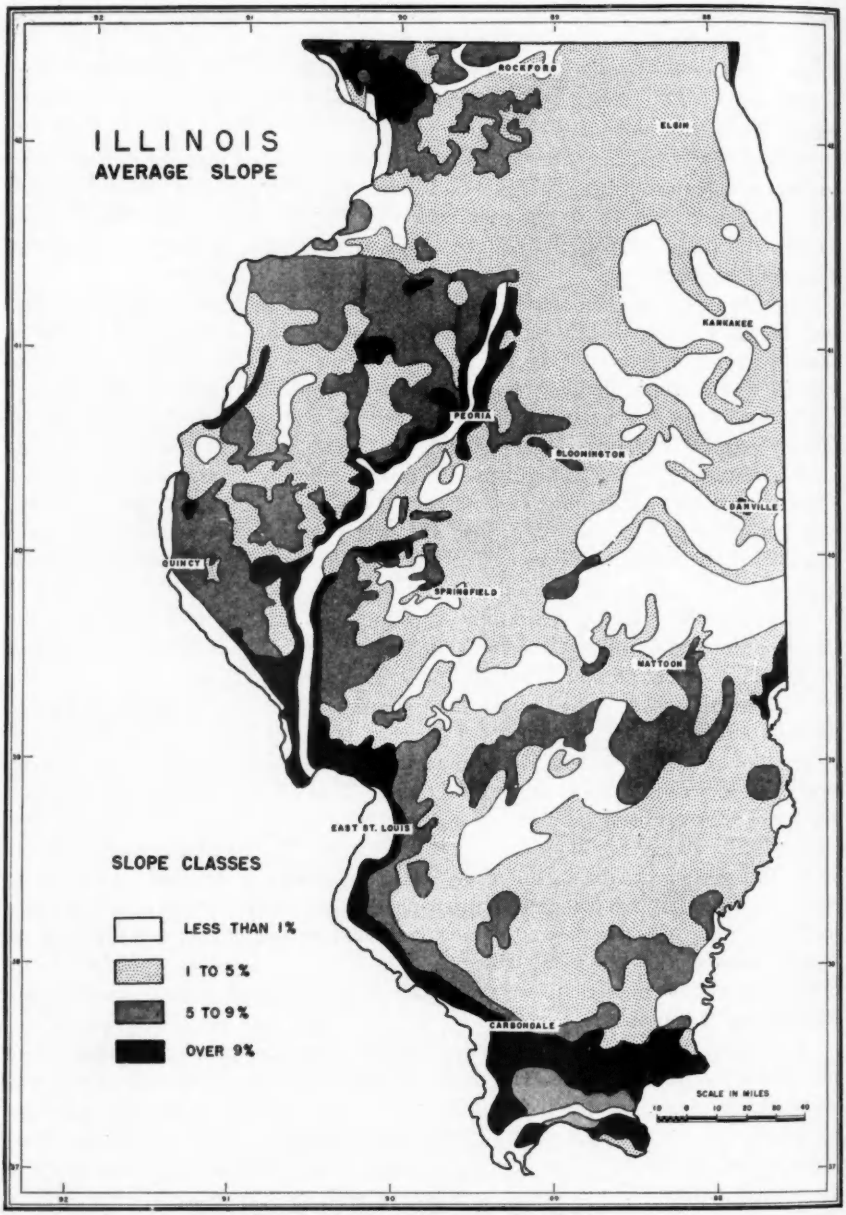

FIG. 1. Average slope map of Illinois.

have appeared in north central and northeastern Illinois. In other words, the depiction of real differences in terrain in eastern Illinois would have been suppressed in order to depict other differences within the large area now shown as 1–5 per cent.

If the isopleth treatment of arbitrary areal units is used, there is introduced not only the subjectivity of the slope class intervals but also that of the size of the arbitrary areal units. Smith,[10] for example, has not only drawn some general conclusions about conditions in Ohio based on his relative relief map, but also some fairly specific conclusions. The conclusions may be genuine and valid, but we may be permitted to speculate as to whether he would have come to the same conclusions about the same areas had he used either larger or smaller arbitrary units, and if he had drawn his boundaries on the basis of 50 meter intervals instead of 100 foot intervals. Moreover, there is inrtoduced the problem of the masking effect on real differences in terrain which the arbitrary unit imposes.[11]

In the discussion of the class-interval problem with respect to the construction of a map by the method used in making the average slope map of Illinois we have assumed that it is possible accurately and confidently to draw boundaries around areas of unlike slope conditions. In fact, this is not true at all. We may illustrate this by reference to Figure 3.

It is perfectly clear from the figure that there are two kinds of slope conditions in the area—very low-angle slopes on the river bottom and the interfluve and much steeper slopes on the eroded upland edge. But the difficult question is whether or not we shall differentiate more than two slope areas. It is clear that the area lying between the two dashed lines has slope conditions quite different from the areas lying to the north and south of it. If we differentiate this area we will then have a very flat area in the extreme south, a moderately sloping area between the dashed lines, and an area of steep slopes just south of the river flood plain. If, however, we decide to divide the southern part of the map into only two areas, along the dot-dash line, we conceal the fact that between the area of steep slopes and the area of flat land at the extreme south there is an area of moderately steep slopes. Conversely, if we decide to show this moderate-slope area we thereby increase the average slope of the steepest area and decrease the slope of the area in the extreme south. If simultaneously these shifts in areal grouping cause shifts of the areas from one slope category to another, it immediately becomes apparent how highly subjective the making of such a map becomes. Moreover, increasing the scale of the map is of no assistance, because the possibilities of showing other transition areas are thereby increased.

Conditions similar to those shown in Figure 3 are found along many of the streams in the flatter portion of Illinois. In areas where the bands are broad and wide they show up as areas of steep slope. But in many cases, the width of these

[10] G.-H. Smith, *op. cit.*

[11] This matter is discussed in W. Calef, "Slope Studies of Northern Illinois," *loc. cit.*, and need not be repeated here.

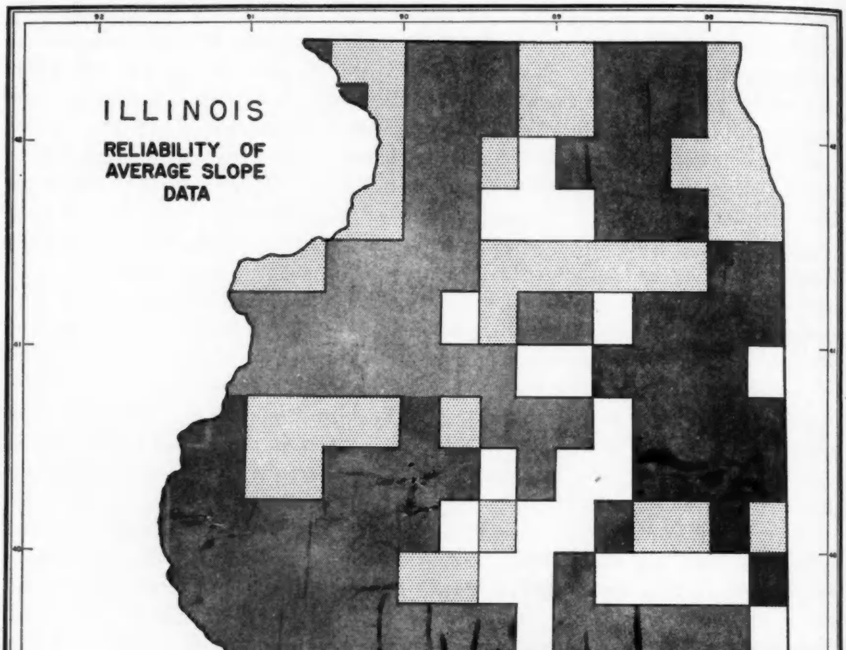

FIG. 2. The relative reliability of the average slope map. Based largely on the status of topographic mapping in Illinois.

bands is not sufficiently great to enable them to be represented even on a scale of 1:1,000,000. Consequently, though the total area of such conditions is rather large, and although this roughening of the surface adjacent to streams is one of the significant features of the terrain of the flatter areas of Illinois, such features are not indicated on the map. The problem involved here, however, is not simply the

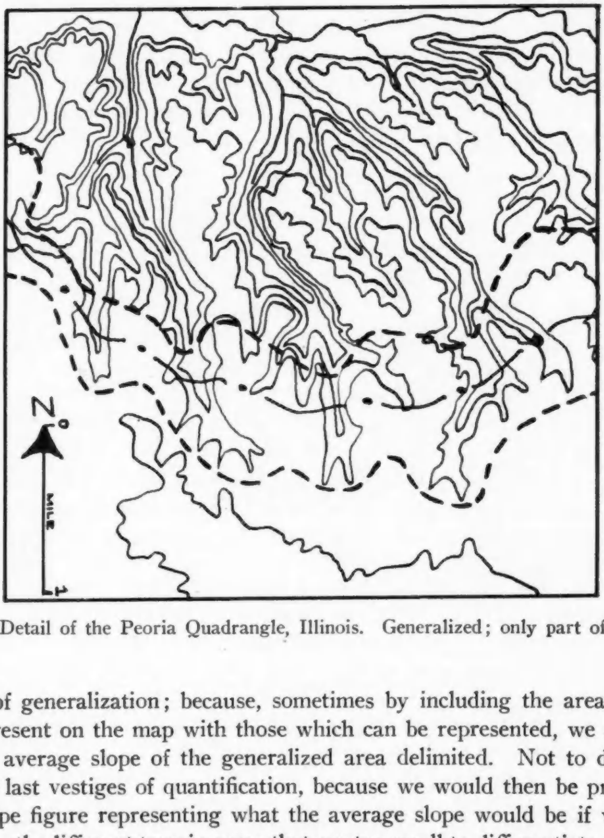

FIG. 3. Detail of the Peoria Quadrangle, Illinois. Generalized; only part of the contours are shown.

usual one of generalization; because, sometimes by including the areas which we cannot represent on the map with those which can be represented, we significantly change the average slope of the generalized area delimited. Not to do so would remove the last vestiges of quantification, because we would then be presenting an average slope figure representing what the average slope would be if we removed the significantly different terrain areas that are too small to differentiate on our map.

AVERAGE SLOPE: A HIGHLY ABSTRACT CONCEPT.

The notion of the average slope of an area is a highly abstract concept; so abstract, in fact, that even persons familiar with the properties of maps showing average slope are apt to attempt to read more from them than they are really capable of presenting. Average slope figures for an area do not necessarily reveal anything about the angle of real slopes in an area, nor do they indicate that any particular

part of an average slope area has average slopes that fall within the slope class limits indicated for that area. These points can be made clear by reference to Figure 4. Making certain assumptions about scale, the average slope for the entire area would be approximately 3 per cent. Yet it is plain that the average slope is made up of two contrasting kinds of slope; most of the area has almost no slope (less than one per cent), but the three areas of closely spaced contours have slopes of over 10 per cent. Thus, so far as can be determined from the contour lines, there are no slopes in the area which have angles approximating the average slope of roughly 3 per cent. It should also be clear that if this entire area is designated as lying within a 1–5 per cent slope class, no part of the area has average slopes falling within the slope classification limits for the whole area. For example, in Figure 4 all the parts

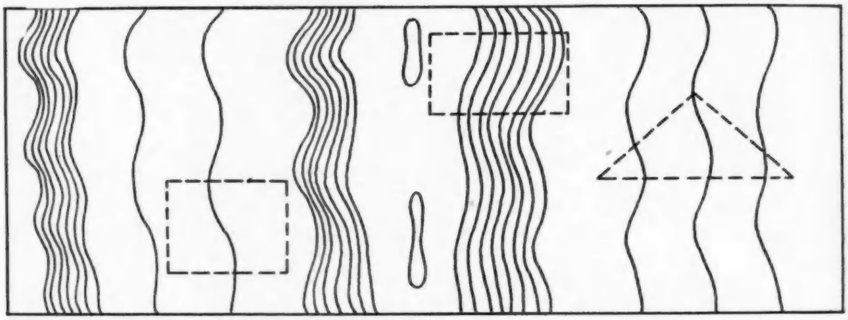

FIG. 4. Hypothetical section of a topographic map.

of the area lying within the three dashed geometric figures do not have average slopes falling with the 1–5 per cent slope classification limit.

It might be objected that the illustration chosen is an extreme case: but it is not. Some sheets have greater complexity, others have less. The real point is, however, that any area comprises a huge number of slopes of different angles combined in different proportions. The average of all of them reveals nothing about either the real slope angles or their relative proportion. The only exception to this statement occurs in extremely flat areas. The extensive areas of less than one per cent average slope in eastern Illinois are of this type. We know that either all the slopes must be very low angle slopes or that areas of steep slope must occupy an utterly insignificant portion of the total area. Except for this extreme case an average slope figure gives no conclusive information about the average slope of any part of the area or about the angles of any actual slopes within the area.

One of the greatest dangers in the use of statistical maps of terrain lies in the tendency to read things into the maps and then assume that they can be read from the maps. Raisz and Henry,[12] for example, call their average slope map a "relative relief" map. It is true that there is commonly a rather close correlation between relative relief and average slope, but there is no necessary relationship between the

[12] *Op. cit.*

two unless the areas for which the relative relief is calculated are very small. If the relationship exists it must be read into the map, the map itself cannot reveal it. Trewartha and Smith[13] recognized this by saying that their relative relief map "shows only the amount of relief." They then fell into the error of supposing that their average slope map of the same area "shows how this amount of relief was gained; whether by steep slopes largely unfit for cultivation, or by milder ones susceptible to agricultural use." There is, of course, no more necessary relationship between real slopes in an area and the average slope in that area than there is between average slope and relative relief. More remote, ancillary, secondary conclusions are even less deducible directly from quantitative maps of terrain conditions.

AVERAGE SLOPE CONDITIONS IN ILLINOIS

With respect to their depiction on the average slope map of Illinois, the terrain features of Illinois may be grouped into three categories: 1) those areas in Illinois that would be revealed by any reasonable statistical map of terrain, 2) those average slope areas of the state that are specifically revealed by the slope categories used for Figure 1, and 3) areas wherein significant and mappable terrain differences are concealed by the categories or scale used for this map.

Numerous statistical maps were made in the course of these investigations of the terrain of Illinois. On all of them, including Figure 1, it is clear that: 1) the eastern half of Illinois is much less rough than the western half; 2) the northwestern corner (the Driftless Area), the extreme south, and the areas bordering the Mississippi and Illinois Rivers are the most rugged areas in the state; and 3) the overwhelming preponderance of all the land of Illinois has low relief and low average slopes. These conclusions are so general and so elementary that it appears to the authors that they could have been sketched in on a map much more quickly and easily than by statistical means, and they could have been characterized much more meaningfully by short qualitative descriptions than by comparisons of average slope.

Numerous additional aspects of terrain conditions in Illinois are revealed by the map because the slope class intervals were selected, in part at least, to reveal those differences. The middle and lower sections of the Illinois River flood plain and the flood plain of the Mississippi and Wabash (in most occurrences in Illinois) are clearly revealed as areas of very flat land. The flat and unusually wide valleys of the Rock River and the Pecatonica drainage in extreme northern Illinois formerly inundated by glacial lakes are clearly characterized and differentiated. The narrow strip of white in the extreme south, an abandoned channel of the Ohio River, is also revealed as being very flat; but this would be differentiated by decidedly different slope classes because of the great contrast in average slope with adjacent areas.[14]

If a line is drawn southwestward from the southern end of the straight eastern

[13] *Op. cit.*, p. 32.

[14] The very narrow low-slope areas in the extreme south and extreme north are good examples of the kind of areas that can be differentiated successfully by the method used in this paper, but which might be completely concealed by the isopleth treatment of arbitrary rectangles.

boundary of Illinois, it will be seen that the area lying immediately to the north and extending off to the northwest contains extensive areas of land having an average slope of less than one per cent, whereas all the area to the south is indicated as having an average slope of over one per cent. This line coincides roughly with the boundary between the Springfield Plain and the Mt. Vernon Hill Country physiographic divisions of Illinois.[15] Both divisions are covered with Illinoian Drift, but the preglacial surface of the Springfield Plain had been greatly smoothed by deposition of Kansan Drift before the Illinoian Till was deposited. Consequently, the surface of the Springfield Plain is much smoother than that of the rock controlled surface configuration of the Mt. Vernon Hill Country to the south.

Along the east bank of the Illinois River south of Peoria, areas of 1–5 per cent slope come right up to the edge of the flood plain of the Illinois over a stretch of more than 40 miles. Immediately east of the river are small areas of less than one per cent slope. This is an extensive area of Quaternary alluvium—outwash material carried down from the moraines to the northeast and mixed with windblown material. The average slope categories used in Figure 1 reveal this terrain area, quite imperfectly, but, nevertheless, definitely. Slightly different slope categories would conceal it entirely.

In the east-central section of Illinois are located the most extensive areas of less than one per cent average slope. In a general way the extensive section of interspersed white and stippled areas indicates the flatter, eastern portion of the Grand Prairie area of Illinois and also indicates that the Grand Prairie area becomes more sloping in its western portions. Had we wished to outline more clearly the Grand Prairie area itself and to emphasize its comparative homogeneity of low-angle slopes, it would have been preferable to make the lowest class "less than two per cent," in which case the white area would have been greatly enlarged. The map also indicates that most of the area of the three large glacial lake beds of eastern Illinois (Wauponsee, Watseka, and Pontiac),[16] have average slopes of less than one per cent. In general the map differentiates the lake beds from the glacial moraines and till plains; but the pattern is not the pattern of glacial deposition, because in some places the moraines are so low and smooth as to have less than one per cent average slopes, and in other places erosion has roughened the surface of the till plains and lake beds sufficiently to raise them to a higher average slope classification.

The very extensive area of 1–5 per cent slope in northeastern Illinois is an excellent example of the suppressing effect of slope categories on the depiction of terrain differences. Originally we mapped this area with an extra category; i.e., the 1–5 per cent category was divided into two classes, 1–3 per cent and 3–5 per cent. With these class limits a fairly meaningful differentiation of terrain conditions in northeastern Illinois was possible. The terrain of this region consists of a com-

[15] For physiographic divisions of Illinois and the locations of glacial moraines and lakes see MM. Leighton, Horberg and Ekblaw, "Physiographic Divisions of Illinois," *Journal of Geology*, LVI: 16–33.

[16] *Ibid.*

plex arrangement of moraines having 3–5 per cent average slope interspersed with till plains of 1–3 per cent average slope. In extending this slope classification to central and southern Illinois these divisions were found to present such serious difficulties in depicting terrain conditions in those areas that it was decided to combine the two, thus suppressing the clear cut and easily mappable distinctions in the terrain of northeastern Illinois.

The area lying between the Illinois and Mississippi Rivers in western Illinois does not have a very meaningful pattern of average slope areas. The terrain of this section has developed as a result of vigorous post-glacial erosion of an originally fairly flat Illinoian till plain. It is at present a very complex association of highly diverse slopes, consequently the pattern shown on the map (Fig. 1) is a highly subjective generalization.[17]

CONCLUSIONS

We have attempted to show that maps of average slope, although they have a quantitative aspect are highly subjective depictions of slope conditions in an area. The sources of the subjective element are: 1) the arbitrary nature of the selection of slope categories, 2) the determinative effect of the selected slope categories on the delimiting of areas of contrasting slope conditions, and 3) the necessity of arbitrary decisions in the delineation of slope boundaries in all areas of gradual areal transition from one slope category to another or in areas of complex associations of widely varying terrain types.

It has been shown that the notion of average slope of an area is a highly abstract concept with extremely sharp limitations of meaning, because it is not necessarily a depiction of any slopes that actually exist in an area or even of the average slope of any part of an area. A danger in the use of such maps lies in the reader's tendency to attempt to arrive at conclusions about actual conditions in an area from average slope data for the area.

The method used in this paper is most satisfactory for areas of sharply differentiated slope conditions, because it permits much more accurate delimitation of boundaries than is possible with other methods. It is so arbitrary and subjective for areas of minor differences in slope as to be almost useless.

From a rigorously scientific point of view average slope maps can be shown to be of only very limited usefulness, because of the demonstrable lack of any necessary relationship between actual slope conditions and average slope conditions, and between average slope conditions and relative relief. Commonly, however, there is actually a fairly close relationship between local relief, average slope, and real slope angles in areas. Consequently, for indicating major distinctions between terrain

[17] Anyone interested in studying the changes in average slope patterns that result from mapping on greatly different scales may consult Richard Thoman, "A New Method of Representing Average Slope, With Western Illinois As An Example," *Illinois Academy of Science, Transactions* XLV: to be published. The map done on a larger scale reveals a much more complex and meaningful arrangement of average slope areas.

conditions over areas of intermediate size, they are, despite their abstract character, of some value, especially when viewed in the light of other known ways of depicting such differences.

The selection of the particular method to be used should be guided solely by the relative effectiveness of the various methods in depicting those differences in terrain conditions which the cartographer wishes to show. Additional knowledge from other sources can make such maps more meaningful, but the map itself can reveal nothing more than the sharply limited, highly abstract concepts about areas which have been described.

The authors offer the value judgment that statistical maps of terrain are of extremely limited usefulness. It is difficult to think of uses for such maps that cannot be better served by other simpler methods. It is the authors' opinion that the greatest utility of statistical maps will be their use as statistical research tools. Statistical maps are inept devices for use in demonstrating facts about terrain areas. However, the compilation of the statistical data and the maps which can be produced from the data through use of different categories or groupings of the data, raise questions about the origin, nature, and correlations of the landforms which show up as statistical anomalies on the maps. A peculiarly shaped area of a certain slope category may raise questions with the investigator and cause him to seek in geologic, topographic, or other sources the reasons why the area is so shaped, or situated, or correlated with other phenomena. Such investigation may bring to light previously unsuspected connections or relationships.

Eventually the usefulness of statistical maps of slope and relief will, of course, be determined by the number and quality of such maps that are made, and by the justifiable uses that can be discovered for them.

AN IMPROVED CURRICULUM FOR CARTOGRAPHIC TRAINING AT THE COLLEGE AND UNIVERSITY LEVEL

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WORLD War II and unsettled postwar conditions have wrought revolutionary changes in mapping activities. An increasing number and variety of maps are now being produced for service men and civilians. New uses for existing maps are being found and rapid technological advances necessitate the development of new and unique types of maps.

The demand for more and greater variety in maps has brought about an expansion of established map-making facilities and the creation of new agencies, both private and government. This expanding activity has posed several problems: 1) mass production techniques had to be improved; 2) new inks, papers, and other materials were needed; and 3) additional personnel had to be trained. In typical American fashion the new techniques, material, and the expanded facilities to house them were solved with relative ease, but, perhaps also typically American has been our lag in changing cartographic training to meet the needs of the present day.

Increased demands for map-makers have induced many American colleges and universities to add cartography courses to their curricula. Prior to World War II very few courses in cartography were offered in the United States, but now well over one hundred institutions of higher learning offer training in the subject. Unfortunately, increasing the number of courses does not solve the problem of poorly trained map-makers. That cartographic instructors are cognizant of the need for improved training in map-making is evidenced by numerous articles in recent issues of professional journals and by the repeated attention this problem receives at national meetings. For example, the last two round table discussions of the cartographic section at the meetings of the Association of American Geographers were devoted to the problem of cartographic training. The training problem is so complex and involved, however, that these rather brief treatments serve mainly to point out new deficiencies and to air old complaints.

This report results from a study of cartographic training made by the author during the twelve month period ending September 1, 1952. A fellowship[1] made possible full-time research into the problem and liberal travel allowances gave opportunity to visit many of the leading cartographers in the United States.

[1] This study was undertaken by the author during his tenure of a fellowship granted by the Fund for the Advancement of Education to enable him to broaden his qualifications for college teaching. It represents the independent work of the author, and he is solely responsible for it.

OBJECTIVE AND SCOPE OF THE STUDY

The objective of this report is the presentation of a cartographic training curriculum at the college level, which meets the needs of present day map-making. The research on which this paper is based was directed toward finding out answers to the following questions:

1. What are the major deficiencies in present day cartographic training?
2. What should be the objectives of cartographic training?
3. Where does cartography best fit into the college curriculum?
4. What subject matter should be included in a program of cartographic training?

Answers to these questions were sought from employers of cartographers, practicing cartographers, and teachers of cartography. More than two hundred informants were consulted in twenty governmental map agencies, nine commercial or quasi-commercial map companies, and ten universites. Slightly more than one half of these calls resulted in interviews complete enough to be used in the report. In addition, the cartographic work carried on by these organizations was studied with special interest centered on the training needed to prepare functioning cartographers.

WHAT ARE THE MAJOR DEFICIENCIES IN PRESENT DAY CARTOGRAPHIC TRAINING?

It is almost impossible to discuss cartographic training with any practicing cartographer or employer of cartographers without being overwhelmed by a spontaneous outburst of complaints. All types of inadequacies are pointed out, ranging from complete rejection of the present curricula down to changing only details. Before analyzing these complaints, however, it seems wise to look back into recent cartographic history and examine some of the reasons for the high degree of dissatisfaction with the products of contemporary cartographic training.

Cartography has only recently been recognized as a field of specialization in the United States and therefore there is a limited background of teaching practice. Prior to World War II very few educational institutions offered any training in the field, and what was offered was very limited in scope. Practicing cartographers frequently drifted into map-making from other occupations, usually with little or no formal training and often with limited experience. Practically the only thread of unity in cartography was an understanding of the utility of maps.

That the amorphous nature of the past carried over to contemporary cartography can be seen by comparing accepted definitions of the field. "Cartography is considered as the science of preparing all types of maps and charts, and includes every operation from original surveys to final printing of copies."[2] And—cartography is "the production of maps, including construction of projections, design, compila-

[2] *Modern Cartography.* United Nations, Department of Social Affairs, Lake Success, New York, 1949. p. 51.

tion, drafting, and reproduction."[3] The first definition considers any type of work, however remotely connected with map-making, as cartography—thus geologists, hydrographers, geodesists, surveyors, photogrammetrists, printers, etc. are all cartographers. The second definition, on the other hand, recognizes the need for a variety of specialists in mapping and limits the cartographer to those phases which take place after the basic information is collected.

It is clear that the first definition requires a superman in training and abilities. Certainly most cartographers accept the second as being closer to their own. The word cartography as used in this report refers to that area of map-making which starts with the evaluation of source materials and follows along with map design, compilation, drafting, and finally ends with some supervision of map reproduction.

Several other factors have served to limit the effectiveness of cartographic training. With the increase of cartography courses, many inexperienced instructors were pressed into service. Too often, cartographic laboratories are poorly equipped and map libraries totally inadequate. In addition, research in the field of cartography has been limited, and a large part of the research which has been done is not available to the instructors.[4] Perhaps even more important than these has been the fact that academic cartography has suffered from too great an emphasis on theory; too little time and effort has been spent on the practical application of theory. Theorizing on art does not make an artist, knowledge of medical theory does not make a qualified doctor, and talking about maps (and listening to lectures on cartography) does not mean that the student can execute a map.

Not all of the blame for present and past deficiencies in cartography can be laid in the lap of the academicians. Too many employers of cartographers have reacted to the academic stress on theory by overrating experience. Experience is invaluable, especially in mapping technology, but in practice it is almost always limited to one type of map problem and the production techniques involved. Frequently, those who decry academic training expect "green" college graduates to possess the maturity of judgment and graphic skill that can be gained only with years of experience.

Poor cartographic training has resulted in poor maps, but the average American, unable to discriminate between good and bad maps, has brought no pressure to bear on producers of poor maps.[5] Thus there has been little incentive for employing

[3] Clarence L. Barnhart, Ed. *The American College Dictionary.* New York City: Harper & Brothers Publishers, 1948. p. 185.

[4] Governmental mapping agencies have been leaders in cartographic research, but, because many of them are intelligence agencies, their research results are often classified.

[5] "Any body can publish any kind of a map, however bad, and get away with it. Ordinarily a field is subject to the law of natural selection—the things that are bad or inadequate fail to survive. But in cartography this law does not operate effectively because the ability to discriminate among maps is not widespread in this country." Richard Edes Harrison, "Cartography in Art and Advertising," *The Professional Geographer,* II, No. 6 (November 1950): 12.

cartographers trained in theory since little or no competitive advantage has resulted from improved map quality.

In addition to these general observations on the inadequacies of cartographic training, many complaints of a very specific nature were encountered. These are primarily concerned with subject matter content of the field of cartography and are treated in another section of this report.

WHAT SHOULD BE THE OBJECTIVES OF CARTOGRAPHIC TRAINING?

The increasing demand for cartographic training on our college and university campuses comes from highly diverse interests. Some students wish to become professional cartographers, others want to make and use maps as tools for a better understanding of their own disciplines, while others are interested only in intelligent map-use and are not concerned with map-making. In addition, there are those who procure, evaluate, and file maps for the use of others.

Objectives which seem to meet these highly diverse demands for cartographic training are:

1. *Cartographic training should stress the fundamental principles of the field as a whole.* One of the primary objectives of university training is to develop in the student a basic understanding of his discipline so that he may go on from there to the limits of his capabilities. This is especially desirable in cartography since there is need for so many talents and skills in the profession that they cannot all be covered in a training program. Attempts to train for specific jobs are futile indeed.

One of the major criticisms of past and present cartographic training, and justifiably so, has been the limited scope of cartography courses. Few sponsoring departments have taught cartography in such a manner that it is related to and integrated with other fields. Instead they have limited training to those phases of cartography which are most useful in their special area of interest. For example, geographers have stressed small scale maps and frequently ignored large scale topographic maps, and engineering departments have placed their stress in a reverse ratio. If cartography courses are to serve their function, this narrow approach to the subject should be done away with and training should be given in all phases of the subject.

2. *Cartographic training must include numerous opportunities for applying theory to actual map problems.* Cartographers should receive a substantial part of their training in the laboratory. Time and again during my recent visits I have heard the complaint, "Academically trained cartographers may know theory, but only exceptional graduates can put the theory to work." This is not a plea to turn completely to techniques and technology, but it is a suggestion that bears serious thought. Certainly no university program in cartography can turn out students accomplished in the manipulation of all of the materials and instruments which a

cartographer needs, but the university trained cartographer should know of their existence and be familiar with their operation and utility.

Ability to perform is as necessary to cartography as it is to any other field. Who ever heard of an artist who couldn't paint or draw, a musician who couldn't play or compose? In the same way, every cartographer should be able to plan, compile, and draft a map.

3. *Cartographic training should encompass a wide range of general and technical courses in allied fields.* Good maps result from the wedding of fine graphic rendition and thorough understanding of the subject matter represented since the cartographer, unlike the photographer, must use selective judgment in planning and compilation. Of equal importance to the cartographer is knowledge of the methods and techniques used in the disciplines of surveying, photogrammetry, geodesy, photography, printing, etc.

Table I is a compilation of answers to the question "What background or allied courses do you feel are desirable for cartographic trainees?" The great range of recommended subject matter emphasizes the wide scope of cartography and the many variations which can be found in the field. Obviously, no single individual can encompass all of these allied fields, but the more of them a cartographer is familiar with the better qualified he will be.

4. *Cartographic training should be available to students in many disciplines and in varying degrees of intensity.* This objective recognizes the need for flexibility in training since maps serve various individuals and disciplines in different ways and in varying degrees of utility. The objectives of some students may be increased intelligence in map use and appreciation of the efficacy of maps. Others may wish training which will enable them to produce simple maps to accompany professional papers in their field, while still others may see cartography as their future life's work. By organizing courses properly a program of cartographic training can be "tailor-made" to suit the needs of the individual.

Recognition is also made here of the usefulness of combinations such as cartography and medicine, cartography and geology, cartography and anthropology, cartography and economics, etc. Many small map-making and map-using organizations are greatly interested in dual majors.

WHERE DOES CARTOGRAPHY BEST FIT INTO THE COLLEGE CURRICULUM?

The scope of theoretical cartography and its associated technology is broad enough to justify the organization of independent departments, at least in the minds of some cartographers. Prof. George H. Harding, in discussing the lack of complete and formal education in the profession, comes to the conclusion, "So apparently the modern cartographer, having come of age so to speak, must leave the 'old homestead' of civil engineering and establish his own home if he is to achieve his destiny."[6] Prof. Wilbur Zelinsky suggested a school of cartography at the Cartographic Panel

[6] George H. Harding, "A Possible Solution to the Problems of Surveying and Mapping Education," *Surveying and Mapping,* XI, No. 2 (April–June, 1951): 105.

during the national meetings of the Association of American Geographers at Worcester, Massachusetts on April 6, 1950.[7] Other practicing cartographers, concerned with the present inadequate training, have also made similar recommendations to me personally during the past year.

TABLE I

Courses in Allied Fields Recommended for Cartographic Trainees by Personnel in Government, Commercial and Quasi-Commercial Mapping Organizations

Allied Field	Federal Government Mapping Agencies	Commercial or Quasi-commercial Map Companies	Total
Lithography & Printing	17	4	21
Photogrammetry	16		16
Air Photo Interpretation	13		13
Surveying	13		13
Geographic Field Methods	10	1	11
Regional Geography	7	1	8
Landforms	7	1	8
Mathematics	7		7
Physical Geography	5	1	6
Political Geography	5	1	6
Art	1	3	4
Geology	4		4
Foreign Language	3	1	4
Hydrography	3		3
Statistics	2	1	3
Physics	2		2
Scientific Writing	2		2
Soils	2		2
Climate	1		1
Library Science	1		1
History		1	1
Political Science		1	1
Advertising		1	1

From a practical standpoint, however, few universities could justify the heavy expense necessary to acquire the additional staff for such departments, even if personnel were available.[8] The demand for professional cartographers is relatively small when compared to other disciplines and probably will not become much greater in the future. For example, one of the major professional organizations of cartographers, The Congress of Surveying and Mapping, has less than three

[7] Discussion (Following the Cartographic Panel of the Worcester meetings of the Association of American Geographers), *The Professional Geographer*, II, No. 6 (November 1950) : 23.

[8] Richard Edes Harrison said in answering Zelinsky at Worcester, that while a separate school of cartography was a sound suggestion "Probably nothing could be done about it in the near future, because of the difficulty of financing it and of filling out a faculty." *Ibid.*

thousand members. Thus the demands from a profession of this size could be satisfied by cartography departments in a few schools.

Separate departments of cartography, even if established at only a few schools, could do much to improve the quality of training for professional cartography, but one of the major objectives of cartographic training would not be met by such an arrangement. Instructors in cartography must accept their obligation to students in other disciplines. Cartography has become, and will continue to become, an increasingly useful and necessary tool for specialists in many other fields. Most cartographic training in the past has resulted not from the demand for professional cartographers, but from the awareness of the need for cartography by such disciplines as Geography, Engineering, Geology, Forestry, Architecture, Economics, Sociology, and others. This is a need which occurs on every university campus and one which would not benefit from the organization of a few "super" departments of cartography on isolated campuses. The need for this type of training by large numbers of students is so important from the educational point of view that it cannot be ignored.

If we accept the three propositions: 1) cartographic training is almost universally inadequate at the present time, 2) separate cartography departments could improve professional training, but are impractical for most universities, 3) cartography is needed on all campuses by students in many disciplines, we find ourselves in the same dilemma which has been with us for some time. How, then, can adequate cartographic training for both professional cartographers and students in other disciplines be achieved on the average university campus? The solution to this problem is not out of reach on most campuses if the following adjustments can be made:

1. Broaden the scope and content of present cartography courses to provide more complete subject matter coverage.

2. Accept the obligation to train students from all disciplines. In most cases this can be done by minor course changes and changing prerequisites to open courses to students from allied or associated fields.

3. Open courses in allied fields to students wishing to specialize in cartography. (See Table I for a listing of courses in allied fields considered to be desirable training for cartographers.)

4. In some cases a degree in cartography could be given by setting up an interdepartmental committee to supervise the curriculum of those students wishing to specialize. These steps would adapt present course offerings in cartography and associated fields to the needs of the student body. Obviously, such a program lacks the integration and supervision of a separate department, but it accomplishes much toward improving and broadening training in cartography. It has the added advantage of being practical from the economic point of view since it fits into the framework of established departments and can be adjusted to suit the individual circumstances found in each school.

WHAT SUBJECT MATTER SHOULD BE INCLUDED IN A PROGRAM OF CARTOGRAPHIC TRAINING?

The objective of this study has been to determine and define the subject matter content of a cartographic training curriculum at the college level. Four aspects essential to such a cartographic training program are: 1) an understanding of cartographic concepts, 2) the development of cartographic skills, 3) a knowledge of map-making instruments and their use, and 4) familiarity with graphic materials and processes. Any program of cartographic training must recognize the necessity for training in all four of these aspects.

A new body of fundamental data pertaining to subject matter content of cartography was obtained from interviews with eighty-eight practicing cartographers and employers of cartographers. A tabulation of these opinions is found in Table II. Each informant was asked to answer the question "What subject matter should be included in a college cartographic training program?" The practicing cartographers and employers of cartographers interviewed were employed in twenty governmental and nine commercial mapping organizations. About equal numbers of supervisory and non-supervisory personnel were consulted.

A breakdown of the academic and experience backgrounds of the informants shows diversity. Those with academic training in cartography came from a great many disciplines such as geography, engineering, geology, forestry, etc., and have as their common denominator one to several courses in cartography. Some have had as many as thirty years practical experience in the field while others have had less than one year of experience. Thus the sample cuts across contemporary cartography as it is practiced by our leading map producing agencies.

In evaluating Table II it must be remembered that the subject matter content listed there results from replies to the question "What subject matter should be included in a college cartographic training program?" No check list or questionnaire was used to obtain the information since it was felt that spontaneous answers to the question were much more valuable than answers stimulated by a long list of subjects which tend to influence the informant. This accounts for the relatively low percentage of answers for any one category, since the natural tendency was for the informant to present those aspects of cartographic training which were of immediate interest and concern. Thus the value of Table II is strengthened since it not only presents the relative importance of any single phase of cartography but the diversity of subject matter listed gives a good measure of the breadth of scope considered to be essential by practicing cartographers.

The validity of Table II can be questioned to a degree in that it may reflect "hind-sight" on the part of the informant. There is a tendency for the successful practioner of a profession to believe that his training was ideal. As a result, there may be an overemphasis in some categories since a very large proportion of the individuals contacted had at least some engineering training in their background. There is also the tendency on the part of an informant to emphasize those aspects of training which were especially deficient in their own, or their employee's back-

ground. Unfortunately, the author was unable to ascertain to what degree these tendencies may have affected the results of the interviews as presented in Table II.

The first four items listed in Table II are highly significant in planning a cartography curriculum. The skills of drafting and compilation are as old as

TABLE II

Subject Matter Content of Cartography Curriculum Recommended by Personnel in Government, Commercial and Quasi-commercial Mapping Organizations

Subject Matter Content	Federal Government Mapping Agency	Commercial or Quasi-Commercial Map Company	Total
Drafting	28	11	39
Materials and Instruments for map-making	21	6	27
Photographic processes used in map-making	23	4	27
Compilation methods and techniques	17	9	26
Sources of map-making data	22	3	25
Editing and proofing maps	17	6	23
Map projections	20	3	23
Map scales	19	3	22
Geodetic control	17	1	18
Color separation in map-making	14	3	17
Evaluation of map-making data	15	1	16
Map reading and use	14	1	15
Map planning and design	9	3	12
Place names on maps	9	3	12
Symbolization of maps	10	1	11
Selection of data in map-making	7	2	9
Typography	7	2	9
Research techniques in map-making	6	2	8
Cataloguing and filing maps	6	1	7
Generalization of map-making data	5	2	7
Map grids	7		7
Costs in map-making	4	2	6
Reduction and enlargement in map-making	6		6
Hand lettering	5	1	6
Interpolation and use of tables in map-making	5	1	6
Map specifications and their use	4		4
Bearings and Azimuths	3		3
Number of Interviews	73	15	88

cartography itself but they are still in great demand. Also considered essential is a knowledge of the materials, instruments, and photographic processes used in map making. All four of these aspects of cartography emphasize the need for laboratory instruction as an essential part of the training.

It is, no doubt, equally as significant that such phases of cartographic training as map planning and design, selection of map making data, research techniques in map making, and the generalization of map making data are so far down the list. The author was keenly aware of their importance in the cartographic work being carried on in the organizations visited. Perhaps this is a bright spot in our present training, but it may well be that other, and to my mind less important phases of cartography, are lacking to a greater degree. Many teachers of cartography would agree that all of these aspects of training listed are essential, but few would wholeheartedly agree with their relative importance as shown by Table II.

Table II is only one of several guides which were used in compiling the basic checklist of subject matter of cartography which follows. The cartographic training programs of the ten universities visited were studied and many suggestions came from instructors at these schools. The cartographic work being carried on by the various organizations visited was analyzed in light of training needed. Literature on cartography and the teaching of cartography was consulted. In addition, my own experience both as a student and as an instructor of cartography was utilized.

The problem of presenting the subject matter of cartography is difficult of solution. It seems impractical to present a teaching outline since it is firmly believed that the cartography courses given at a given institution should be (yes—must be) tailored to fit the individual needs of that institution and the instructoral personnel. Since this is the case, subject matter is presented here as a basic check list of content in cartography. Attempts have been made to make it as complete as possible but the relative emphasis on each phase of the training and the order of coverage were not considered in its compilation.

Subject Matter Check List of Cartography

- History of Maps
  - Emphasis on the development of maps and mapping
    - Increased accuracy
    - Changing techniques
    - More and more of earth's surface being mapped
    - Increasing variety of maps
  - Much yet to be done in mapping earth's surface
    - Little known about wide areas of earth's surface
    - Increasing knowledge and technology increases need for more and new types of maps
- The Earth
  - Shape
  - Size and dimensions
  - Movements
- Earth Grid Systems
  - Latitude and Longitude
  - Atlas Grids
  - Rectangular Survey (Township-Range)
  - State Coordinate System
  - Military Grids

- Projections
  - Need for systematic arrangement of earth grid on a plane surface
  - Desired characteristics of projections
  - Types of projections
  - Deformation of projections
  - Selection of proper projection
  - Graphic construction of projections
  - Construction of projections from tables
- Measurement of Distance, Direction and Area
  - Distance
    - Length of 1° Latitude
    - Length of 1° Longitude
    - Other units of measurement used on maps
    - Methods of distance measurement
  - Direction
    - Compass Rose
      - True North
      - Magnetic North
      - Azimuths
      - Bearings
      - Loxodromes
    - Great Circles
  - Area
    - Units of Areal Measurement
    - Methods of Areal Measurement
- Map Scale
  - Relationship of maps to earth
  - Methods of expressing scale relationship
    - Representative fraction
    - Graphic
    - Verbal
    - Areal
  - Determination of unknown map scale
  - Transforming scales
  - Changing from one map scale to another
    - Methods
    - Effect upon map detail
  - Plotting to scale
- Map Research and Evaluation
  - Sources of materials used by cartographers
    - Map publishers
      - Area and subject matter coverage
  - Sources of Aerial photographs
  - Sources of statistical and descriptive data
  - Prominent libraries specializing in cartographic materials
  - Cataloguing and filing maps
- Evaluation of Map Source Materials
  - Accuracy
  - Technical rendition
  - Aesthetic rendition
  - Does it do the job intended?

- Date
- Publisher and reputation
- Marginal information (source of data, how compiled, classification of features, projection)

Map Reading and Map Interpretation
- Types of maps and map problems
  - Stress familiarization of student with as great variety as possible.
  - Practice in interpreting cultural and physical features on maps.

Aerial Photographs
- Use of aerial photographs in cartography
  - General introduction to photogrammetric technique (What type of material do cartographers get from photogrammetrists?)
  - Use of photo index, photo mosaic
  - Radial Line Plot
  - Photo interpretation
  - Use of Stereoscope

Map Planning
- Visualizing a map to suit the need
- Search for source materials
- Evaluation of source materials (realiability and suitability)
- Economics
  - Methods of reproduction
  - Time estimate
  - Cost estimate
- Planning around the above limitations
  - Choice of scale
  - Selection of projection
  - Selection of detail to suit purpose and scale
  - Number of colors

Map Design
- Fundamentals of map design
- Design to fit purpose and desired emphasis
- Effect of reproduction processes on design
- Visualization of finished map-layout
  - Overall patterns
  - Patterns in detail
  - Selection of style and size of type
  - Selection of line weights
  - Contrast and emphasis

Symbolization
- Need for symbols
- Fundamentals of good symbolization
- Qualitative and quantitative symbols
- Point, line, and area symbols
- Selection of symbols to suit purpose of map
  - Suitability of symbol design
  - Relationship of single symbols to map as a whole
    - (Harmony, visability, part of overall pattern of the map)

Control
- Need for horizontal and vertical control
- Sources of control data

- Plotting control on graticule
- Datums—converting data from one to another
- Cadastral survey data of use of cartographer

Compilation
- Common compilation procedures
- Need for geographic background and understanding of:
  - Map subject matter
  - Selection of detail to give honest representation of the area
  - Intelligent generalization of detail
- Relation of compilation to map-making processes which follow (especially reproduction)
- Materials and instruments used in compilation
- Changing data to uniform units
  - Scale conversion (Pull-ups and diapositive mosaics, pantograph, Photostat, reflecting projector, square-method)
  - Use of tables in converting measurements to the standard
- Compilation drafting

Type Matter on Maps
- Geographic Names (Board of Geog. Names and Their Work)
  - Transliteration
  - Glossaries
- Methods of applying type matter to maps
  - Free hand lettering
  - Mechanical lettering devices
  - Stick-up lettering
  - Placement of geographic names and type matter
  - Type styles and sizes used on maps
  - Ordering stick-up
  - Reaction of type matter to reproduction processes

Methods of Map Reproduction
- Offset Lithography
- Letter press
- Photostat and photographic processes
- Blue print, Ozalid, Van Dyke, etc.
- Economics of the various methods
- Preparation of map copy for reproduction
  - General requirements for all types of reproduction
  - Specific requirements for each type of reproduction
  - Additional requirements imposed in reproduction by television camera
- Visit reproduction plant

Map Editing, Proofing, and Revision
- Map proofs (Black and white, Ansco-color, dye color)
- Editing (accuracy, technical rendition, aesthetic rendition)
  - Check list
  - Overlays

Diagrams, Graphs, Cartograms, and Miscellani
- Essentials of graphs
- Pictorial maps and graphs
- Block diagrams
- Relief maps
- Line, area, volume, and logarithmic curves and their application to cartography

Procedures in Map-making Organizations

Typical flow of work
Relation of each process to those before and after
Cartographic specialization

* Map-Making Instruments
    - Use and care of:
        - Pens, dividers, scales, and other small instruments
        - Brushes
        - Air brush
        - Chartograph
        - Lettering guides
        - Slide rule
        - Reducing glass
        - Planimeter, map measure
        - Shop microscope
        - Pantograph
        - Reflecting projector
    - Photography as a cartographic tool
    - Availability and cost of instruments

* Graphic Materials
    - Drafting surfaces
        - Characteristics and utility in relation to effect
        - Ease of manipulation
        - Stability, transparency, translucence
    - Paints, Pencils, inks
    - Availability and cost of materials

* Map Drafting
    - Drafting specifications
    - Color separation drafting
    - Drafting for reduction and/or reproduction
    - Drafting on plastics
    - Negative engraving
    - Tricks of the trade

A FUNCTIONAL INTRA-DEPARTMENTAL CARTOGRAPHY TRAINING PROGRAM

The arrangement of the subject matter of cartography within the limitations inherent in an intra-departmental situation with limited teaching personnel is difficult. This is especially so because maximum flexibility to meet the needs of students with highly diverse objectives is essential. The following course arrangement is presented with the full realization that modifications to suit the instructional personnel and objectives of any given institution may be necessary.

Five courses comprise the core of the suggested curriculum:

Course 1. Elementary training in projections, grids, scales, lettering, symbolization, and simple map drafting.

Course 2. The use, availability, and evaluation of maps.

Course 3. Planning, compiling, and constructing small scale maps, primarily subject matter maps.

* These three aspects of cartographic training can probably be best taught at the university level by introducing the students to them piece-meal as they carry out their laboratory exercises.

Course 4. Planning, compiling, and constructing large scale maps, primarily topographic maps.

Course 5. Non-technical training in the preparation of simple manuscript maps for persons wishing the minimum in the manipulative aspects of cartography.

Courses 1 and 2 would have no prerequisites. Course 5 would have as its only prerequisite 10 hours in the students' own field of specialty. Courses 3 and 4 would have course 1 as a prerequisite. All except possibly course 2 would be laboratory courses with strong emphasis on application of theory to actual map problems. Additional work could be made available to students wishing to specialize in cartography through the means of special reading or special problem courses.

While this program is not set forth as the ideal answer to present day training problems in cartography, it does serve as an example of what can be done in a situation where a separate department of cartography is impractical. It represents an effort to organize the subject matter in accordance with a basic philosophy of cartographic training. Under this concept there are the obligations to provide training, both sound and as broad as possible for those whose major interest is cartography; to serve the needs of students and staff in the parent department; and to provide opportunity for interested students in other fields to attain some degree of competence in this discipline. This three-fold obligation provides the major challenge for the improvement of cartographic training.

THE FUNCTIONS OF NEW ZEALAND TOWNS*

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NEW ZEALAND is young in length of European settlement. Although the sites of one or two towns are more than 100 years old, all urban development has taken place in less than a century. In this short period the towns of these two islands have acquired a uniform and individually characterless appearance with their typical elongated business areas, checkerboard street patterns, and repetition of cream colored, frame houses with red galvanised iron roofs and neat front gardens.

To the superficial observer these urban areas appear to be simply market towns of varying size, but of similar mold, each serving a tributary farming community and each responding with increased commercial activity to the weekly and seasonal rhythms of its rural hinterland. Because of this apparent uniformity among New Zealand towns an analysis of the functions which they perform becomes of particular importance as a means of differentiating clearly among them. As a result this aspect of urban geography probably takes on an even greater significance in New Zealand than in most other countries. It is therefore of interest to distinguish the kinds of New Zealand towns on the basis of their functions and to classify the urban areas of this small country.

METHOD

The most practical method of classifying New Zealand towns according to the different functions which they perform consists of analysing the occupational structure of each town.[1] But to assign the greatest weight to the function which employs the largest number of people in a town and to classify urban areas on this basis is to overlook the fact that in all towns there is always a certain proportion of the population engaged in the manufacture and distribution of goods and in the provision of services. It is only where an "abnormal" percentage of the population of an urban area is engaged in any single function that that function becomes a distinguishing feature. These abnormalities may be recognized initially by the construction of national means and the measurement of deviations (or functional indices) from these means.

In the calculation of national means either of two bases could have been selected: means for employment groups for all urban areas with more than 1,000 population;

* This study was made possible by a grant from the Research Committee of the University of New Zealand to whom grateful acknowledgment is made.

[1] The calculation of the amount of surface area devoted to different uses is both impractical and theoretically imperfect as a measure of functional importance, and no statistics are available in New Zealand for comparing the incomes of employment groups in individual towns. C. D. Harris established the relative importance of different functions in towns by assigning higher percentages to some functions than to others on the basis of an analysis made of cities of well recognised types. See "A Functional Classification of Cities in the United States," *Geographical Review*, XXXIII No. 1 (1943): 86–99.

or means for employment groups in towns of approximately the same size. To consider all urban areas together presupposes that approximately the same percentage of the population is engaged in identical functions in all New Zealand towns irrespective of their size. This is not so. It is more logical to construct national means for towns of approximately the same size rather than to group urban centers of 1,000 people with, say, metropolitan populations 200 to 300 times larger. This assumption has been taken as the basis of the present study.

TABLE I

Means for Functional Groups in New Zealand Towns of Approximately the Same Size (April 1950)

Size of towns (000's)	91–308	19–53	7–12	4–7	3–4	2–3	1–2
Number of towns	4	11	7	11	11	20	36
FUNCTIONS	NATIONAL MEANS Percentage of Total Population in Different Functions						
Residential	64.36	69.85	65.81	69.02	66.69	71.35	71.73
Manufacturing, Building and Construction	15.78	11.86	12.68	12.75	13.29	11.24	9.88
Primary Industrial	0.09	0.13	0.37	0.08	1.29	0.17	2.55
Transport & Communications	4.04	3.89	4.55	3.95	5.29	4.27	4.36
Distribution & Financial	8.06	6.57	7.19	7.53	6.45	6.02	4.84
Hotel & Personal Service	1.81	2.10	2.61	2.26	2.36	2.16	2.05
Administration & Professional Service	5.41	4.92	6.12	4.00	3.67	4.09	2.98
(Workers not included)	0.45	0.68	0.67	0.41	0.96	0.72	1.61

Source: Location and Decentralization of Industry—District Office Returns, April, 1950; Dept. of Labour and Employment, N.Z.

In April and October of each year statistics are collected by the Department of Labour and Employment stating the number of workers gainfully employed in 69 different industrial codes, ranging from bush sawmilling through the manufacture of footwear to road transport and arts and sciences and religion. From the April, 1950 survey, means were calculated for some six different employment groups (combining the majority of the 69 industrial codes) in all towns of more than 1,000 population and of approximately the same size.[2]

[2] In 1950 one hundred towns in New Zealand had a population of more than 1,000, 67 per cent of this total being in the North Island and 33 per cent in the South Island. Of the total population of New Zealand 68 per cent is in the North Island and 32 per cent in the south. The absence of settlements between 12,000 and 19,000 and 53,000 and 91,000 population is a feature of the urban geography of New Zealand which has yet to be studied by New Zealand geographers.

The positive deviations from these national averages are taken here as criteria expressing the relative importance of six different functions: manufacturing, building and construction; primary industrial; transport and communications; distribution and financial; hotel and personal service; and administration and professional service. The seventh class, that of the residential function, is based on the national means calculated for the percentage of the total population gainfully employed in towns of approximately the same size. A positive deviation implies that the percentage of population in a town in actual employment is higher than normal; conversely, a negative deviation implies that fewer people are employed than is to be expected in a town of that size, that is, the urban area in question is a residential center by national standards[3] (Table I).

CLASSIFICATION

An analysis of the occupational structure of New Zealand towns shows that all have at least one distinguishing function of national significance[4] (Table II). For

TABLE II

Number of Significant Functions Performed by Different Classes of New Zealand Towns
Based on positive deviations from national means
(Negative deviations for residential function)

Functional classes	Per cent of N. Z. towns in different classes	Per cent in class with one function	Per cent in class with two functions	Per cent in class with three or more functions
Residential	52	17	41	42
Manufacturing, Building and Construction	44	6	32	62
Primary Industrial	17	6	18	76
Transport & Communications	42	2	7	91
Distribution & Financial	52	0	6	94
Hotel & Personal Service	37	0	14	86
Administration & Professional Service	44	0	14	86
ALL TOWNS		15	27	58

the purpose of this paper, however, it is most convenient to classify each town by individual functions so that a town with four functions will be classified in four

[3] For Papatoetoe only 8.86 per cent of the total population is actually employed within the town itself by comparison with the national average for towns of 4,000 to 7,000 population of 30.98 per cent, thus giving Papatoetoe a negative deviation of 22.12. In Table I the figures relating to the residential function are the complements of the national means for the gainfully employed population.

[4] It may be noted that there is no discernible relationship between the number of functions performed by an urban center and the range of deviations.

different sections irrespective of the fact that only one is predominant.[5] At the same time it should be noted that 85 per cent of New Zealand towns have more than one significant function by national standards and that to classify towns systematically in the above manner is "logical" rather than "realistic." The functional composition of each town as a whole, however, is described in Figures 1 and 2.

Residential Towns

No less than 52 per cent of New Zealand towns may be classified as residential centers in that they all have negative deviation from their respective national means (Fig. 3). These urban areas range in size from the metropolis of Auckland with its population of more than 300,000 down to the township of Winton with only 1,070 people. The functional index from place to place also covers a wide range varying from 0.05 for Eltham to 25.22 for Runanga, although 48 per cent of the towns have deivations greater than 5, and 23 per cent have deviations in excess of 10.

Two major groups of residential towns may be noted: those within a radius of 30 miles of Auckland; and those in the south-eastern part of the North Island between Masterton and Featherston where they are separated from Wellington by the barrier of the Rimutaka Ranges. Outside of these two main areas of concentration seven pairs of adjoining towns can be observed in which the residential functions are greater than the national means: Huntly and Ngaruawahia; Napier and Hastings; Levin and Otaki; Nelson and Richmond; Greymouth and Runanga; Dunedin and Mosgiel; and Gore and Mataura. In most of these there is a daily interchange of workers between towns.

By comparison with all other classes of urban areas residential towns have the greatest proportion performing only one function (Table II). The number of functions performed by residential centers is related to the type of town into which they may be further classified. Three different categories of residential towns might be suggested tentatively: dormitory towns for city workers; dormitory towns for employees in industries outside of urban areas; and centers to which people retire in unusually large numbers.[6] Quite evidently the residential towns around Auckland come within the first category. In addition employees often reside in one center and travel to an adjacent town such as from Ngaruawahia and Cambridge (to Hamilton), Waitara (to New Plymouth), Mount Maunganui (to Tauranga), Feilding (to Palmerston North), Upper Hutt and Lower Hutt (to Wellington), Richmond (to Nelson), Mosgiel (to Dunedin), and Bluff (to Invercargill); but, in contrast to the first group, these centers are not wholly or even primarily dormi-

[5] In practice the two leading functions of Pahiatua, those of distribution and finance, and administration and personal service, are of the same relative importance. For the remaining 99 towns, however, one function does predominate.

[6] At present no practical method exists for defining objectively different classes of residential towns in New Zealand.

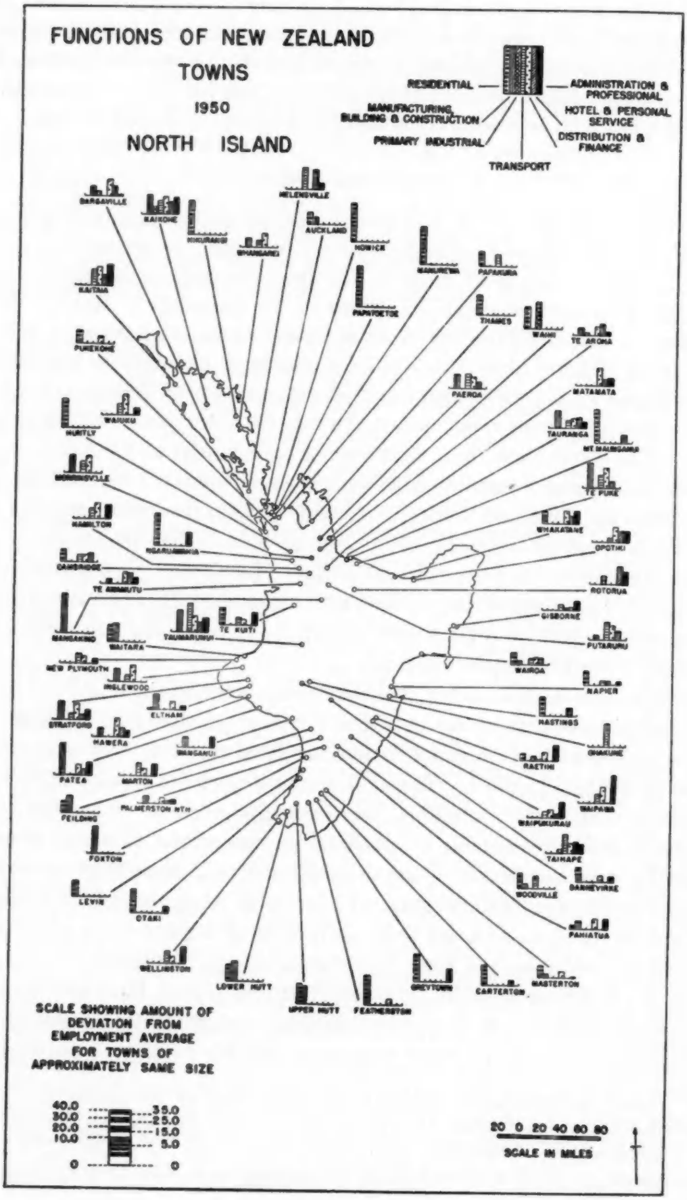
FUNCTIONS OF NEW ZEALAND
TOWNS
1950
NORTH ISLAND
RESIDENTIAL
MANUFACTURING, BUILDING & CONSTRUCTION
PRIMARY INDUSTRIAL
TRANSPORT
DISTRIBUTION & FINANCE
HOTEL & PERSONAL SERVICE
ADMINISTRATION & PROFESSIONAL
DARGAVILLE
KAIKOHE
HIKURANGI
WHANGAREI
HELENSVILLE
AUCKLAND
HOWICK
MANUREWA
PAPAKURA
KAITAIA
PAPATOETOE
THAMES
WAIHI
TE AROHA
PUKEKOHE
PAEROA
MATAMATA
HUNTLY
WAIUKU
TAURANGA
MT MAUNGANUI
MORRINSVILLE
TE PUKE
HAMILTON
NGARUAWAHIA
WHAKATANE
OPOTIKI
CAMBRIDGE
TE AWAMUTU
ROTORUA
GISBORNE
MANGAKINO
WAITARA
TAUMARUNUI
TE KUITI
PUTARURU
NEW PLYMOUTH
WAIROA
INGLEWOOD
NAPIER
ELTHAM
STRATFORD
HASTINGS
HAWERA
WANGANUI
OHAKUNE
PATEA
MARTON
RAETIHI
WAIPAWA
PALMERSTON NTH
FEILDING
WAIPUKURAU
FOXTON
TAIHAPE
LEVIN
OTAKI
WOODVILLE
DANNEVIRKE
PAHIATUA
WELLINGTON
LOWER HUTT
UPPER HUTT
FEATHERSTON
GREYTOWN
CARTERTON
MASTERTON
SCALE SHOWING AMOUNT OF DEVIATION FROM EMPLOYMENT AVERAGE FOR TOWNS OF APPROXIMATELY SAME SIZE
40.0 30.0 20.0 10.0 0
35.0 25.0 15.0 5.0 0
20 0 20 40 60 80
SCALE IN MILES

FIG. 1.

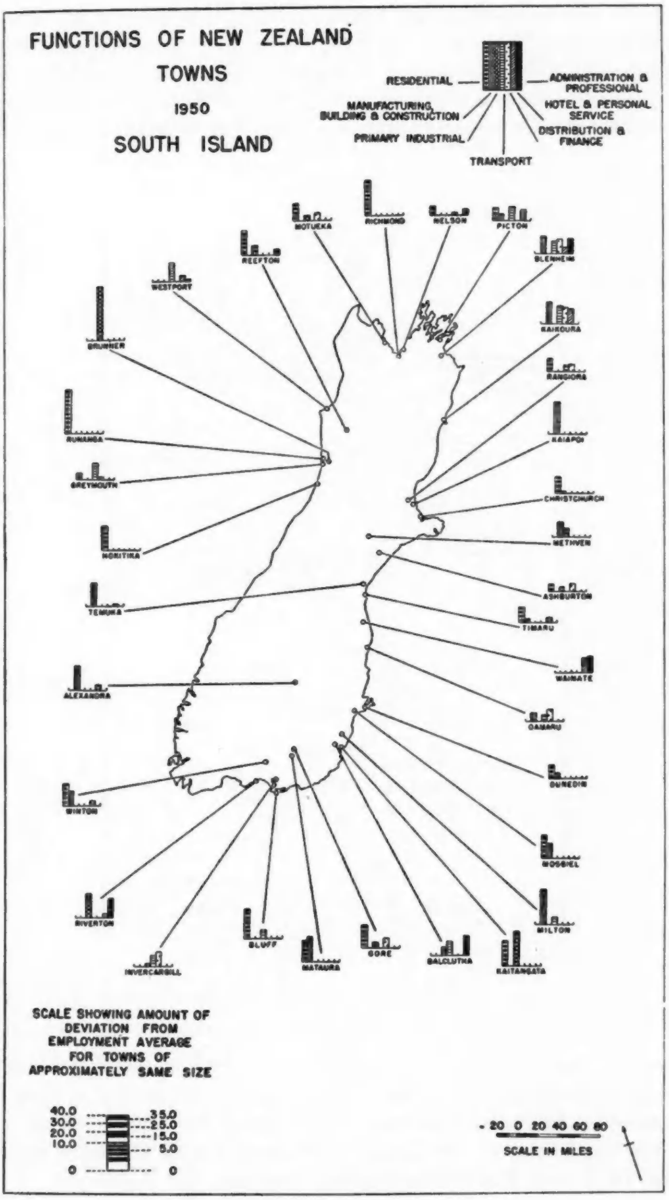
FUNCTIONS OF NEW ZEALAND TOWNS
1950
SOUTH ISLAND
RESIDENTIAL
ADMINISTRATION & PROFESSIONAL
MANUFACTURING, BUILDING & CONSTRUCTION
HOTEL & PERSONAL SERVICE
PRIMARY INDUSTRIAL
DISTRIBUTION & FINANCE
TRANSPORT
MOTUEKA
RICHMOND
NELSON
PICTON
REEFTON
BLENHEIM
WESTPORT
KAIKOURA
BRUNNER
RANGIORA
RUNANGA
KAIAPOI
GREYMOUTH
CHRISTCHURCH
HOKITIKA
METHVEN
ASHBURTON
TEMUKA
TIMARU
WAIMATE
ALEXANDRA
OAMARU
DUNEDIN
WINTON
MOSGIEL
MILTON
RIVERTON
BLUFF
GORE
BALCLUTHA
KAITANGATA
MATAURA
INVERCARGILL
SCALE SHOWING AMOUNT OF DEVIATION FROM EMPLOYMENT AVERAGE FOR TOWNS OF APPROXIMATELY SAME SIZE
40.0 30.0 20.0 10.0 0
35.0 25.0 15.0 5.0 0
-20 0 20 40 60 80
SCALE IN MILES

FIG. 2.

tory towns for city workers (Figs. 1 and 2). In another group of eight towns—Napier and Hastings, Wellington and Lower Hutt, Dunedin and Mosgiel, and Gore and Mataura—the daily interchange of workers is particularly marked. This indicates, in all cases except Wellington where building space is physically restricted, an uneconomic situation resulting from the prevailing shortage of houses.

FIG. 3.

The second class of residential center, that of dormitory towns for workers employed outside of urban areas, is exemplified by the coal mining centers of Hikurangi, Runanga, Reefton, and Kaitangata; the paper mill town of Whakatane; and the lime-working center of Te Kuiti. Retirement towns, the third category, are represented by Mount Maunganui, Napier, Hastings, and Richmond.

Manufacturing, Building, and Construction Towns[7]

Manufacturing, building, and construction towns form the third largest group of New Zealand centers with 44 per cent of all urban areas coming within this classi-

FIG. 4.

fication (Fig. 4). Variations in both population numbers and deviations cover a range as great as that of residential centers, but only 29 per cent of the towns have functional indices greater than 5.

[7] Manufacturing includes all types of manufacturing and processing industries (National Employment Service Codes 11–54); building and construction includes all developmental work such as irrigation, land development (other than farming), highway construction, hydroelectric building and construction, water supply, and the construction and renovation of buildings. (National Employment Service Code 56.)

Towns in this class are concentrated in one major and two minor groups. The largest and most striking grouping is the string of towns extending from Waitara to Patea in Taranaki and including every town in this zone with a population of more than 1,000 inhabitants. These centers owe their industrial importance universally to food processing industries and the maintenance of farm vehicles and machinery, chiefly meat freezing works at Waitara and Patea, bacon curing at Hawera and Eltham, and butter and cheese factories in all towns except Patea. Of the two minor groups the towns in Manawatu around Palmerston North are individually more diversified in their industrial structure. Palmerston North itself not only processes dairy produce and maintains farm equipment, but also manufactures a wide variety of goods. Feilding, like Waitara, is both a meat and a cream processing center, while Foxton is dominated by its *phormium tenax* factory.[8] The three manufacturing centers of the Hauraki Lowland—Paeroa, Te Aroha, and Morrinsville—are similar to Taranaki centers in that they are dairy processing and machinery servicing towns; meat processing industries are notably absent from these northern urban areas.

In addition to the three groups located in the main dairying regions of New Zealand there are two other pairs of important manufacturing, building, and construction towns—Tauranga and Te Puke, and Upper Hutt and Lower Hutt. The major towns in this functional class are generally isolated centers, however, with the sole exception of Patea. The complete absence of manufacturing towns on the West Coast of the South Island and the relative lack of importance of similar towns on the North Island's east coast are equally as striking as the distributions which have already been noted.

The majority of the manufacturing, building, and construction towns are multifunctional (Table II). This type of urban area may also be subdivided first, into building and construction towns, and second, into manufacturing centers and subclasses.

Within the first category are Mangakino, the urban center of the Waikato hydroelectric power project; Kaikoura, a road improvement base town; and Alexandra, the headquarters of the Central Otago irrigation schemes. Among the different types of manufacturing towns, the primary processing and machinery maintenance centers have already been noted as have also the widely diversified industrial cities.[9] An additional type of manufacturing center in New Zealand consists of towns, such as Foxton, which are dominated by a single major industry based upon primary produce other than that derived from livestock, or based upon partially processed animal products. Included in this category are the three woollen mill towns of Kaiapoi, Mosgiel, and Milton; the pottery center of Temuka; and the paper mill town of Mataura. It is of interest to note that more than 80 per cent of towns in this sub-class are located in the South Island and, furthermore, than the

[8] *Phormium tenax*, or "New Zealand flax," is an indigenous, fibrous plant of the same genus as the Mexican sisal. See H. J. Critchfield, "Phormium Tenax—New Zealand's Native Hard Fiber," *Economic Botany* V, No. 2 (1951): 172–184.

[9] By New Zealand definition a city is an urban area with a populaiton of at least 20,000.

most important manufacturing towns, measured by national standards, are all dependent upon one main industry.

Primary Industrial Towns[10]

Seventeen per cent of New Zealand towns come within the category of primary industrial centers. This category is, thus, the smallest functional class of

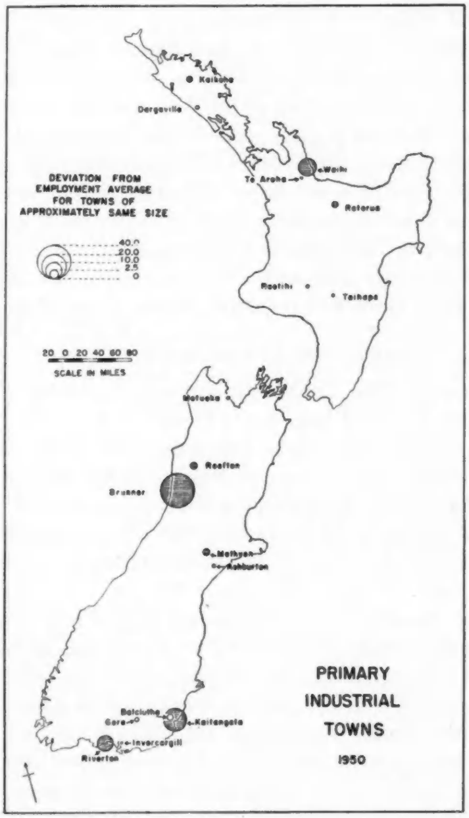

FIG. 5.

urban area, but it is the most distinctive in range of functional indices with Brunner having a deviation of 37. However, this is not representative for only 33 per cent of the towns have deviations of more than 5. Although they vary in size from the city of Invercargill (30,900) down to boroughs of slightly more than 1,000, the towns of major importance all have less than 4,000 inhabitants (Fig. 5).

[10] Primary industries include agriculture contracting, forestry, bush sawmilling, mining and quarrying among others. (National Employment Service Codes 3-5, 8-10).

Primary industrial centers are also predominantly multi-functional in character (Table II). Further, they are less concentrated than any other type, the only region of significance being the West Coast of the South Island. Of the seventeen towns in this class, the South Island has no less than 59 per cent. This is unusual in view of the fact that only 33 per cent of all towns of more than 1,000 population are located on this island. Three of the four most important primary industrial towns are on the southern island because there mining towns are more often located on the actual field than in the north.

The primary industrial towns fall into four classes: mining and quarrying; bush sawmilling; forestry; and agricultural centers. With the exception of Riverton, which is a bush sawmilling center, all of the major urban areas are mining towns: Waihi for gold; and Brunner, Reefton, and Kaitangata for coal. The smaller centers, such as Kaikohe, Dargaville, Raetihi, Taihape, Motueka, and Methven, have bush sawmills, while Rotorua is the major forestry town in New Zealand and Ashburton is the only outstanding center for agricultural contracting. The relative lack of importance of primary industries in towns outside of Waihi, Brunner, Kaitangata, and Riverton indicates that with these exceptions few New Zealand towns owe their importance to extractive industries within their urban boundaries.

Transport and Communication Towns[11]

Forty-two per cent of New Zealand urban areas are transport towns varying in size from Wellington, the third largest city,[12] to the small town of Milton (1,580); the most important centers, however, all have fewer than 10,000 inhabitants (Fig. 6). The range of deviations among these centers is smaller than in any of the other types of towns already described with a maximum of only 12 at Taumarunui, while 93 per cent have a functional index of less than 5. Seventy-five per cent of the transport towns are located in the North Island which also contains the four major transport centers.

Of the different classifications of towns considered this far, transport centers have the most even distribution and reflect most closely the general pattern of population distribution. The greatest concentration of major transport centers, however, does not correspond with the general distribution of population, but is located near the center of the North Island along the Main Trunk Railway where towns are small and rural population is sparse. The importance of Taumarunui, Ohakune, and Taihape is due largely to the number of workers engaged in maintaining the railway line through the rugged countryside and in servicing and operating the additional engines necessary for hauling trains in this area.

In addition to the railway centers are road transport towns, such as Kaikohe, Paeroa, Opotiki, Kaikoura, and Waiuku. All New Zealand transport towns have both rail and road services with the sole exceptions of Kaikohe and Opotiki, while

[11] Transport and communication include rail, road, water and air transport and post, telegraph and telephone services, but excluding the loading and unloading of ships. (National Employment Service Codes 57–61).

[12] But the second largest "metropolitan" area by Census Department definition.

nine transport towns have port facilities as well. The largest of the latter class are Westport and Greymouth where coal is railed to the wharves for shipment.

No New Zealand town is predominantly an air center; indeed, no urban area provided with regular air services has an index greater than the 4.3 of Westport, which town is also an important port, rail, and road center. The major transport

FIG. 6.

towns of New Zealand, therefore, are railway centers and are predominantly multi-functional in composition (Table II).

Distribution and Financial Towns[13]

One of the two largest classes of New Zealand towns numerically is the distribution and financial centers, which include 52 per cent of all urban areas (Fig. 7).

[13] Distribution and finance includes wholesale and retail trade, stock exchanges, trust companies, and insurance and other agencies such as house and estate, advertising and travel agencies. (National Employment Service Codes 62–65).

The variations in the sizes of these towns is essentially the same as that for transport towns, but the significant ones vary from 31,000 inhabitants (Hamilton) to 1,060 (Waiuku), with an expectable predominance of towns of less than 2,000 population. The range of functional indices is even less than for transport towns; no center has a deviation greater than 5.8. With 96 per cent having indices of less than 5, there is more uniformity in the relative importance of towns of this type than in any other class of urban area in New Zealand.

FIG. 7.

The distribution of these towns is interesting in two respects: first, no fewer than 79 per cent are located in the North Island, and, second, three important clusters can be discerned. To the north of Auckland two thirds of the towns of more than 1,000 population are distribution and financial centers of appreciable importance; in Waikato and Bay of Plenty (between Waiuku, Te Awamutu, and Opotiki),

80 per cent of the towns are of this type. Of these, 40 per cent are of national significance. In Taranaki (between New Plymouth and Patea), half of the urban areas are major towns within this category. Most of the remaining regions of New Zealand have district centers of some importance, such as Invercargill in Southland and Gisborne in Poverty Bay. The absence of a regional center between Oamaru and Gore, the relatively slight importance of Greymouth to the West Coast of the South Island, and the insignificance of Palmerston North in Manawatu suggest three exceptional areas where the functions of towns are more specialised than elsewhere.

Distribution and financial centers are further distinguished by the fact that they all perform more than one function, no less than 94 per cent having three or more functions of importance—the highest percentage for all classes of towns—and only 6 per cent having two functions. Yet in only 12 per cent is distribution and finance predominant (Figs. 1 and 2).

Although National Employment Survey Statistics do not classify separately wholesale and retail distribution, it would appear from field studies in New Zealand that warehouses are almost exclusively confined to towns of approximately city size, such as Hamilton, Gisborne, New Plymouth, Palmerston North, Napier, and Invercargill.[14] Even these towns, however, are dominated by the warehouses of the four "metropolitan" areas of Auckland, Wellington, Christchurch, and Dunedin, only one of which is classified here as a distribution and financial town. But Wellington is probably even more important financially, for all company and state banks and most agencies have head offices in this city because of its central location and its importance as the seat of government. With the exception of Wellington, however, all distribution and financial centers function as market towns serving the needs of their rural hinterlands.

Hotel and Personal Service Towns[15]

For a small country New Zealand has a great variety of scenic resources, but this potential has not been fully exploited. Furthermore, the typical New Zealander does not spend his holidays in hotels, preferring instead to camp or rent a cottage at some resort, generally on the sea coast. It is not surprising, therefore, that only 37 per cent of New Zealand towns are classified as hotel and personal service centers, and that the maximum deviation among them is no greater than 5.3 (Fig. 8). Only one town has a functional index exceeding 5 and 73 per cent of them have deviations of less than 2. Thus these urban areas are characterised by the uniformly low relative importance of their hotel and personal service functions. They are also exclusively multifunctional (Table II), while in numbers of population they range from metropolitan areas to towns of just over 1,000 inhabitants.

[14] Because of distance and transport difficulties Whangarei is also a minor wholesale center.

[15] Hotel and personal services include the provision of lodging, food and drink, laundries and dry cleaning establishments, care of the person, and recreation, amusement and sport. (National Employment Service Codes 66, 68–71).

Two main groups may be recognised: those north of Auckland, and those in Waikato and Bay of Plenty. The northern half of the North Island not only has a majority of hotel and personal service towns as might be expected solely on the basis of population distribution, but also contains the four leading towns in this class. With the exception of Taihape, Hawera, Picton, and Kaikoura, no town of any functional importance in this category lies outside of the northern quarter of New Zealand.

FIG. 8.

Hotel and personal service towns in turn may be divided into resort and holiday towns, and transient accommodation centers, although both have generally a dual character to a limited extent. For its size, Helensville, with its hot springs, is the leading resort town in New Zealand while Rotorua, in the heart of the thermal district, is second in relative importance. Te Aroha is another center with hot

springs although the provision of accommodation for commercial travellers is an important adjunct as is the case at the resorts of Picton and Tauranga. The small town of Mount Maunganui on the seaward side of Tauranga Harbour, though, is exclusively a beach resort and the only example of this type of urban area in New Zealand.

The major transient accommodation centers, therefore, are located either at transport terminii, such as the railhead of Kaikohe; at intermediate road transport centers, such as Opotiki and Kaikoura; or at some central place in areas which are not readily accessible, as for example at Kaitaia and Taumarunui.

Administration and Professional Service Towns[16]

Forty-four per cent of urban areas in New Zealand come within the category of administration and professional service towns and vary from metropolitan size of the smallest of urban centers (Fig. 9). The range of functional indices is slightly greater than in distribution and financial, and hotel and personal service towns; Waipukurau has an index of 9.8 although this is lower than the maximum of any of the other classes of urban areas apart from the above exceptions. There is also a considerable measure of uniformity in the relative importance of these centers. With the exception of Waipukurau, Kaitaia, and Balclutha, all urban area in this class have indices of less than 5, and 34 per cent of the deviations lie between 2 and 5. As in the case of the three previous types of towns these administration and professional service centers are predominantly multi-functional (Table II).

Over 80 per cent of these urban areas are located in the North Island, 14 per cent more than is to be expected from the relative distribution of towns on each island. In North Island the towns are evenly distributed with no large areas of concentration. Apparent anomalies, such as the juxtaposition of Waipawa and Waipukurau which are both centers of appreciable importance, are readily explained by an examination of the criteria used in defining this class of town. Whereas Waipawa is largely an administrative town, Waipukurau is the site of one of the main sanatoria in New Zealand in addition to being an important administrtion town. Ngaruawahia, on the other hand, is a county seat only, while Hamilton is an administration center for national as well as local government and the main professional service town for the whole of the Waikato. Kaitaia is another hospital and administration center and Kaikohe is its administrative neighbour; at Opotiki and Whakatane each town has a duel function in this connection, but in Whakatane both administration and professional services are of greater relative importance.

The pattern of distribution throughout the remainder of the island points to local district centers where administration and professional services, either sepa-

[16] Administration and professional services include hospitals, medical and allied services, hygienic services, education and instruction, government and local authority services not already defined and miscellaneous services such as trade unions and political party organizations. (National Employment Service Codes, 72–76, 79–81).

rately or in conjunction with one another, have resulted in certain towns becoming important. At the same time the abscence of similar towns between Blenheim and Waimate, in Central Otago and Southland to the northwest of Balclutha, and in the vicinity of Riverton, indicates that the services tend to be less evenly distributed in the South Island than in the North Island.

FIG. 9.

CONCLUSION

An analysis of this classification indicates some features of the urban geography of New Zealand which might not have otherwise emerged.

Although the towns of both islands are predominantly multi-functional, urban areas in the North Island have a higher proportion with more than two functions, while the South Island has a greater percentage of dual functional centers (Figs. 1

and 2). The greater part of the North Island is dominated by multi-functional towns, only three appreciable areas occurring in which single or dual functional centers are important: first, the urban areas within commuting distance of Auckland—the single function local towns and the most distant dual function centers; second, the single function towns of Southern Manawatu between Foxton and Otaki; and third, the dual function towns of the southeast between Carterton and Lower Hutt. Multi-fuctional centers in the South Island, on the other hand, do not form homogenous areas of comparable size and no regular pattern of distribution occurs.

There is also a disproportionate distribution between the two islands of towns of the same functional class (Table III). Although the North Island has only 67

TABLE III

Percentage of Towns in Functional Classes in North and South Islands

Functional Class	North Island Per cent	South Island Per cent
Residential	64	36
Manufacturing, Building and Construction	66	34
Primary Industrial	41	59
Transport and Communications	75	25
Distribution and Financial	79	21
Hotel and Personal Service	76	24
Administration and Professional Service	81	19
PER CENT OF ALL URBAN AREAS	In North Island 67 In South Island 33	
PER CENT OF TOTAL NEW ZEALAND POPULATION	In North Island 68 In South Island 32	

per cent of the urban areas of more than 1,000 population, it has a disproportionately large number of the distribution and financial, transport, administration and professional service, and hotel and personal service towns. The South Island has an abnormal proportion only of primary industrial towns, while residential, and manufacturing, building, and construction towns are divided between the two islands in approximately normal ratios. It would appear, therefore, that the North Island is better provided with most types of major functional centers than is the South Island. This indicates, possibly, that the North Island is developing more rapidly not only in population, but also in the provision of more urban services for its rural and urban population. It might also be suggested that in distribution and financial, transport, administration and professional service, and hotel and personal service the North Island appears, to the entrepreneur, to have offered more attractive possibilities for the establishment and expansion of business than has the south.

For all types of functions appreciable concentrations of major towns can be defined and general location factors underlying these distributions can be stated.

Thus residential towns owe their importance either to the proximity of larger centers or mineral resources, or to certain physical conditions of climate and topography which make a town desirable for purposes of retirement. The majority of manufacturing centers in New Zealand, though, are found close to the sources of raw materials in the districts of most intensive livestock production. Individual manufacturing towns, on the other hand, with their typical single predominant factory appear to owe their importance to historical accident more than to any other factor. Primary industrial towns, obviously enough, are located on, or near, mineral and forest resources while transport centers are situated in regions of broken surface where considerable maintenance of railway lines is necessary, at the junction of several bus routes, or at change in transport points where, for example, coal is transferred from railway truck or collier. Distribution and financial towns, like most manufacturing centers, are located in the richest agricultural regions of New Zealand although special local conditions, particularly industrial development, result in important exceptions to the general tendency. An intermediate location on a transport route, a central location with respect to districts of somewhat difficult access or scattered population, or a resort attraction all appear to have favoured the development of hotel and personal service towns in New Zealand. A central location is even more important, however, for administration and professional towns although the combination of administrative services and a large hospital in one urban area will also produce a town of national functional importance.

Finally, two general tendencies in respect to the functions of New Zealand towns, may be stated: first, that the greater the population of an urban area, the greater the percentage of population in manufacturing, building and construction, in distribution and finance, and in administration and professional service functions, and the smaller the percentage in residential and in primary industrial functions; and second, that approximately the same proportions of the urban population are employed in transport and communications, and hotel and personal service functions irrespective of the size of New Zealand towns.

REVIEWS AND ABSTRACTS OF STUDIES

SOUTH AMERICAN CITIES

Herbert Wilhelmy, *Südamerika im Spiegel Seiner Städte*. Hamburg: Universität Hamburg, Ibero-amerikanisches Forschungsinstitut, 1952.

The story of a country is recorded in its cities. As Friedrich Ratzel wrote, the life of a people is brought to a focus and summarized, and its processes speeded up in cities. Herbert Wilhelmy makes use of this concept as a frame within which to develop the story of Spanish and Portuguese settlement in America, especially South America.

The contrast between Indian and Spanish is notable, and can be examined with care in such early Spanish-Indian centers as Mexico City and Cuzco. The predominance of the European concepts is reflected in the cities; yet Indian ideas are not entirely lacking.

The checker-board plan characteristic of Spanish cities, and required by law after the city planning directive of Philipp II, has an ancient heritage. It was first proposed, according to Wilhelmy, during the fifth century B.C. by a Greek named Hippodamus of Miletus. The Greeks made use of this plan and amassed a considerable body of experience in the selection of sites for new cities. This experience was brought together in a basic text on city planning by Vitruvius Pollio between 37 and 32 B.C. Few texts have had such a long use: for 1500 years the ideas of Vitruvius guided the location and layout of Latin cities; and when Philipp II codified the laws relating to the construction of cities in the Americas in 1573, he paraphrased Vitruvius. That the two texts run closely parallel is demonstrated by a paragraph by paragraph comparison of nine basic points. Among these are the suggestions that a town should be placed on intermediate slopes, not so high that the site is cold and windy and difficult to reach, nor so low that it is difficult to drain; and that if a town is to be placed on a river, it should be on the east bank so that the morning sun will not be obscured by rising mists. The plaza, both agree, should be of a size which is adjusted to the population of the city, but in any case the length should be one and one half times the breadth. Furthermore, the plaza should be oriented to the prevailing winds in such way that the avenues that lead from it should be open to the free sweep of the wind. Both texts agree on the placing of churches and public buildings around the plaza.

If there was a contrast between Indian and Spanish ideas about cities, the contrast between the ideas of the Spanish and those of the Portuguese was even greater. Before 1492 the ideas of the known world flowed through Lisbon, and no one heritage remained pure and unchallenged. The Portuguese-American city of colonial times was essentially unplanned. Some one in authority established the position of the church or the fort and the city grew up around it according to the whim of the people. As a result Portuguese colonial cities are more intimately adjusted to the sites they occupy than are the Spanish cities. In modern times, these characteristics are to a certain extent reversed: for the Spanish-American seems much less imaginative with respect to the planning of new geometric designs of city layout than the Portuguese-American. There are new Brazilian cities in the pioneer zones with the most varied and incredible geometric patterns.

Wilhelmy presents the story of the location and growth of a number of Spanish and Portuguese cities. He offers a wealth of detail that is most valuable. The cities of Spanish-America he examines are Caracas, Quito, Lima, Bogotá, La Paz, Santiago, Valparaiso, Buenos Aires, Asunción, and Montevideo. In Brazil he describes Pernambuco, Bahia, Rio de Janeiro, and São Paulo. The only example of the new trend in city planning that he discusses is Belo Horizonte, a city that was laid out in the 1890's and is relatively conservative in design.

Throughout Latin America, the characteristic city dwelling is very much like its counter-part in Spain or Portugal. This parallel is striking in comparison to the unusual colonial dwellings found in certain English African colonies, or in Dutch Java. The English and Dutch, Wilhelmy points out, do not remain in the colonial areas permanently, but always plan to return to the homeland. It was not so necessary for them to bring their traditional house types with them as it was, apparently, for the Spanish and Portuguese, who had no intention of returning to their homelands.

For the specialist who is already acquainted with the story of the Spanish and Portuguese

conquest of the native cultures of America, Wilhelmy's book will be welcome and highly stimulating. It presents not only new ideas but also old ones in new connections. Nevertheless, although we can agree that cities do offer a mirror in which are reflected the conditions of the lands and the lives of the people they serve, the reflections are in fact so complex that unless one is already well informed concerning the rural background, the full content cannot be read from them.

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The Plane Table

On the basis of suggestions from many Association members, young, old, and middle aged alike, and with the tacit approval of the Publications Committee, *The Plane Table* is begun as a sort of clearing house for expressions of opinion on matters relating to the *Annals* and to the Association. There is no guarantee that it will appear regularly, or, for that matter, ever again if sentiment is generally against it. Comment can and should run the whole gamut of emotions. The pros and cons of such a section in the *Annals,* in which few, if any, "holds are barred," have been stated and restated; there is a good reason for it to match each good reason against it. So the section is being tried.

The matter of title may be worth a comment. Obviously such trite and worn captions as "Letters to the Editor," "Communications," "The Listening Post," "The Editor's Easy Chair," and "The Editor's Uneasy Chair" are nauseous as well as pedestrian. "Notes and Comment" just fits the concept of the section, but that title is so much a part of, if not really a synonym for the name of, a popular magazine that it is really quite unusable. The editor asked for and received many other suggestions, and they ran all the way from "The Dog House" to "The Third Hemisphere," from "Room 9" to "The Hay Loft." Among them all, "The Plane Table" seemed most nearly adequate; few *geographers,* when they admit the truth, are strangers to the first weak attempts at closing a plane table traverse. Perhaps that will make us all feel easier about some of the contributions (?) which may appear. Or, perhaps we'll find where the errors of our own "traverses" are and how they may be corrected.

There must unfortunately be a few rules for the conduct of the section; one could become pedantic and say that there must be a policy. The editor prefers rules and here they are. 1) *The Plane Table* may *not* be used as a news or advertising agency for persons or institutions. (Those functions belong properly to *The Professional Geographer.*) 2) All true criticism, vigorous or mild, about articles appearing in the *Annals* is invited. 3) The editor must know who is the author of each contribution, and the author's name will be appended to all published statements. 4) The appearance of *The Plane Table* must depend, of course, upon the availability of space *after* the demands for publication of research manuscripts have been met.

* * *

When one calls a halt in one's own oral activities and begins to listen for a space to others engaged in the same discipline, certain rather definite conclusions about that discipline begin to take form. At first it is difficult, almost impossible, to keep silent; listening is the hardest of tasks. But, if one really wants to find "what it is all about" and can persist in his resolve to listen, the self-imposed task eventually becomes a pleasant habit. Only occasionally is it necessary to break the habit and then only as a sort of catalystic nudge to others. Two conclusions which arise from the listening the editor has done are these. 1) Many geographers in the United States are in so much of a hurry "to get someplace" that they pay too little attention to the writings of their co-workers. And 2) far too large a number of geographers take themselves too seriously. Now seems the time for one of those catalystic nudges; hence, *The Plane Table.*

* * *

Remarks on, "Regional Differences in the World Atmospheric Circulation," a paper by John R. Borchert

Professor Borchert's paper, which is cited above and which appeared in a recent issue of the *Annals,*[1] is a highly stimulating one that correctly underscores the dynamic basis of regional climatology. Nonetheless there is considerable question concerning the significance of the five maps that are the core of Borchert's presentation. These remarks are directed to a brief consideration of the significance and interpretation of his maps.

Figures 1 and 2 of Borchert's paper show the zonal boundaries between easterlies and

[1] *Annals of the Association of American Geographers,* XLIII, No. 1 (March 1953): 14–26.

westerlies for January and July as determined on the basis of prevailing surface winds. The significance of these maps either in a dynamic or a climatic sense is open to serious question because 1) the maps do not include consideration of wind force and therefore do not show zonal transport of air, a factor that *is* significant dynamically; and 2) over much of the surface of the earth, north-south flow of air is far more significant in its influence on climate than is east-west flow. For example, Figure 2 shows a zonal boundary between easterly and westerly winds extending across the United States during July along Latitude 38° (approximately), from the Great Basin eastward to the Atlantic Ocean; but the climatic lines for July—lines representing thunderstorm frequency, precipitation, temperature, etc.—are in generalized form either north-south lines through the region of the plains and prairies, or curved lines concentric about the Gulf of Mexico (*see*, for example, the summer climatic maps in the Yearbook of Agriculture, 1941, *Climate and Man*, pp. 705 ff.). Other examples of nonconformity between these figures and climatic phenomena might be cited. The essential point, however, is that except in the heart of the oceanic Trade Wind regions and near the equator, it is meaningless to think in terms of prevailing zonal winds when in fact both the weather and the climate are dominated by moving eddy systems (cyclones) that are dynamic entities in themselves and result in all manner of air flow conditions.

Figures 3 and 4 present a good generalized view of the flow of air over the oceans. It is questionable, however, that the flow as depicted over land is meaningful because frictional effects render highly suspect any streamlines based on surface wind observations. For example, the flow of air onto southeastern Australia during July is predominantly from the southwest rather than from north of west, as is implied by the prevailing wind maps of Figure 4.

Figure 5, which shows the "major static climatic regions derived from seasonal prevailing air mass maps," is especially open to question. This map apparently shows the dominant air mass types for July and January over the continents. Yet in at least some of the regions identified on the map the identifying letters do *not* indicate dominant air mass types. The British Isles is shown to be occupied predominantly by maritime tropical (mT) air during July; but the actual air mass frequencies as worked out by J. E. Belasco for Kew and Scilly show that polar maritime air is three and one half times more frequent than tropical maritime air in July (*see*, A. Austin Miller, "Air Mass Climatology," *Geography*, XXXVIII, Pt. 2 (April 1953): 67, Table II). The map shows that continental air is dominant in the southwestern United States during January, when in fact a rough count of air mass frequencies for a period of ten years indicates that on 52 per cent of the days maritime air was present at Modena, Utah (near the heart of the area shown on the map), and that continental air was present only 32 per cent of the time. On the remaining 16 per cent of the days that were analyzed, the origin of the air could not be determined accurately.[2] Other examples of nonconformity between Figure 5 and actual air mass frequencies might well be given.

As to whether regions of like designation in Figure 5 are homologous or analogous, there is very great question. Certainly the Sahara and eastern Montana are dissimilar both climatically and in a dynamic weather sense. So also are the Ukraine and Rhodesia. Other examples might be cited.

In conclusion, it is only proper to remark that in the body and footnotes of his paper Professor Borchert indicated some of the limitations of his study, that the scale of the maps did not permit the delineation of zones and regions in detail, and that as indicated in a recent letter to me, it was not Professor Borchert's intention that his conclusions be interpreted too literally. Nevertheless, these remarks may prove useful in the interpretation of Professor Borchert's paper which, despite its limitations, contains much that is of value.

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Reply to Dr. Blumenstock's Remarks

Dr. Blumenstock's remarks on my paper in the March issue of the *Annals* correctly note some of the weak points of the paper. They deserve attention and discussion.

[2] These percentage figures, which are indicative rather than conclusive, were obtained through counting the air mass frequencies as shown on the Northern Hemisphere Surface Maps issued by the United States Weather Bureau for the years 1919, 20, 21, 24, 25, 35, 36, 37, 38, and 1939. These years were selected at random from the incomplete files readily available to me. It is estimated that the sampling may be in error by as much as 10–15 per cent.

The purpose of subdividing the circulation pattern into zonal belts was to delineate those areas dominated by frontal wave cyclones in opposition to those dominated by tropical "easterly waves." I believe that this is a significant distinction because of the regional differences which it implies in terms of interdiurnal temperature variability, precipitation type and intensity, and temperature and evaporation conditions immediately following a rainfall. These climatic characteristics need to be mapped in much more detail. The correlation between these different storm-type areas and the zonal surface wind belts is high in some parts of the world, low in others. That fact produced difficulties which I attempted to reduce by including the winter easterlies of Middle Asia in a zone of "middle-latitude westerlies and monsoon easterlies," and the tropical westerlies of the Arabian Sea in a zone of "low-latitude easterlies and monsoon westerlies." The maps that are needed to remedy this deficiency are maps showing the seasonal distribution patterns of middle-latitude wave cyclones and of easterly waves in terms of their frequency, intensity, and other physical characteristics. When such maps are available, there will be no further need to try to approximate their patterns from maps of other elements.

The flow of air in July over the ocean along the coast of south Australia from the Great Bight to the Base Strait is prevailingly north of west according to the sources used for Figures 3 and 4. The data over land are open to several interpretations; and the prevailing flow may be slightly south of west rather than slightly north of west as it is shown in Figure 4. There are, no doubt, greater inaccuracies in these maps. The wind data of the world offer many opportunities for regional study, and there are many gaps in the data yet to be filled. Wind maps could be produced from the existing data which would be far superior to existing published maps; and there will still be opportunity for improvement as more data are accumulated.

A. Austin Miller's article, to which Dr. Blumenstock refers, is accompanied by a map (Figure 1) which designates the prevailing airstream across Britain in July as "TmW", i.e. tropical maritime. Thus Miller's map contradicts his Table II and is in agreement with my Figure 4. It obviously does not follow that the two maps must be correct. There are two possible reasons for this discrepancy. (1) The MP and MT streams over the North Atlantic come from unlike source regions, but then have parallel trajectories for a long distance. Where this is true a mean or prevailing airmass boundary is necessarily most diffuse, and the boundary on the map is probably not wide enough or simply misplaced because of inadequate data. (2) The evidence for rejecting the summer prevailing airmass labels on Miller's map and mine lies in the conclusions drawn from a study based upon the airmass labels on official daily weather maps. And this evidence is, itself, open to serious question. The "airmass calendar" is not a really objective tool nor is it necessarily significant; for it rests in the last analysis upon the judgement of the meteorologists who analyze the weather maps. Those people may disagree in their interpretations of the data because meteorologists, to my knowledge, have never defined the limiting physical characteristics of their various airmass types; nor is there any systematic definition and delineation of the geographical limits of airmass source regions for the benefit of the people who place the airmass labels on the daily weather maps.

The other discrepancies noted between the labels in Figure 5 and "actual" airmass dominance beg further questions concerning the utility of standard airmass labels on the daily weather map for the regional study of climate. Studies by A. C. Gerlach (*Monthly Weather Review*, LXVI, No. 12: 376–377) and G. R. Parkinson (*Bulletin of the American Meteorological Society*, XVII, No. 5: 127–135) show "transitional polar maritime" air dominant over the Great Basin in winter and summer and dominant over the Great Plains dust-bowls in over 90 per cent of the dust storm situations analyzed by Parkinson during the drought of the 1930's! But it seems likely that the air in question is called "maritime" mainly because there is no other term provided for the airmass analyst to apply to most of the air which diverges over the western United States. Similar problems exist in the use of airmass labels on weather maps all over the world.

The regions in Figure 5 most certainly are not analogous in the sense suggested by Dr. Blumenstock. However, places have similar climates if they 1) lie in regions with the same airmass regimen according to Figure 5, and have similar locations with respect to 2)

relief and elevation, 3) continental coast, and 4) latitude—the main genetic factors of climate which Figures 3, 4, and 5 attempt to show.

Dr. Blumenstock is to be congratulated for establishing a modern precedent for published discussion of papers appearing in the *Annals.* I am grateful for his comments.

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